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IN THE GUNROOM

By

MAJOR SIR GERALD BURRARD

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TO
E. P.

PREFACE TO NEW EDITION

IT is now more than twenty years since the first appearance of this little book. The remarkable kindness of the reception which was then given it by the shooting public was, to me at least, almost as surprising as it was gratifying; and few things have pleased me more than the many helpful letters which I have received from fellow shooters in all parts of the world. For it happens that I have now been doing my best to try to supply answers to the many conundrums put forward by interested sportsmen of all ages for a period of thirty years—to those addressed to the *Field* from 1920 to 1932; to others sent to *Game and Gun* from 1924 to 1945; and to yet others which have since been coming to me by diverse channels.

As the years have passed, I have found that some problems seemed to become out of date, while others have been repeated again and again and seem never to lose their attraction or interest. But there have also been new difficulties and possible misunderstandings which must almost inevitably accompany any new departures in firearms and ammunition. Among such are "non-fouling" bullets; "non-rusting" caps; new types of wads; new methods of sealing shotgun cartridges.

In this new Edition I have, therefore, tried to bring the subjects included up to date, while at the same time retaining those which by constant repetition have been proved to be of more than individual or passing interest, and thus increasing the total number of Questions and Answers considerably. The field covered is fairly wide and I can but hope that I may be forgiven for any omissions which may be discovered by some readers; while if a very few Questions and Answers towards the end of the book may seem unduly technical I can but plead the fact that they have been asked repeatedly, and so may possibly be of some interest to somebody.

Various readers have at different times suggested that an Index would be an advantage, an idea for which I am most grateful. So I have included one in this Edition which I trust will be found adequate and helpful.

Finally, I can but try yet once again to offer my so very real thanks to the shooting public whose kindness has encouraged me to offer this new Edition.

GERALD BURRARD.

WILLOW LODGE, HUNGERFORD,
BERKS.
October, 1950.

PREFACE

IT has so happened that for the past ten years I have been responsible for the answers given to all questions dealing with Rifles, Shotguns and their Cartridges which have been addressed to the *Field*. In the course of time I found that certain questions seemed to be of more than passing interest to some individual, as they were constantly being asked at different times by different sportsmen. It was this fact which suggested the idea of publishing a series of those questions which seemed to be of general interest, and this idea resulted in one hundred such questions and answers appearing in the pages of the *Field* under the heading of " In the Gunroom."

Quite a number of my friends have expressed their belief that the publication of this series in one single volume would prove of interest, and even help, to shooters in different parts of the world : and this is my only excuse for the appearance of this little book. But its publication could never have been possible without the permission of the Editor of the *Field*, to whom I would like to express my most real thanks for his great kindness in allowing me to reproduce what has already appeared in that paper.

On the whole the questions and answers are the same as those which were originally published, but one or two have been slightly altered to a form which seems more suitable for a book.

I offer this little volume to the shooting public with extreme diffidence and can only trust that it may prove of the same interest to that public as some of my friends have encouraged me to hope.

G. BURRARD.

WILLOW LODGE, HUNGERFORD,
BERKS.
June, 1930.

CONTENTS

SECTION PAGE

1. THE SIZES OF SHOTGUNS 17
2. THE PATTERNS OF 12, 16 AND 20 BORES AT DIFFERENT RANGES 18
3. IMPROVED CYLINDERS 18
4. CARTWHEEL PATTERNS 19
5. PATTERN GIVEN BY FULL CHOKE 20
6. POSITION OF "CHOKE" IN A BARREL . . . 21
7. EFFECT OF CHOKE ON VELOCITY 21
8. POSSIBILITY OF WIDENING THE PATTERN OF A FULL CHOKE 22
9. LIGHT-WEIGHT 12-BORES 22
10. RECOIL DEVELOPED IN SHORT-BARRELLED GUNS . 23
11. THE BEST LENGTH OF BARRELS FOR SHOTGUNS . 24
12. REPORT FROM DIFFERENT LENGTHS OF BARRELS. 24
13. THE POSSIBILITY OF SHORTENING SHOTGUN BARRELS 25
14. WEIGHT OF TRIGGER PULLS IN SHOTGUNS . . 26
15. RELATIVE ADVANTAGES OF SIDE-LOCK AND BOX-LOCK ACTIONS 26
16. COMPARATIVE QUICKNESS OF DIFFERENT TYPES OF LOCKS 27
17. SINGLE TRIGGER ACTION 27
18. WEIGHTS OF GUN STOCKS 28
19. MEASUREMENTS OF A GUN STOCK 29
20. ALTERATION IN FIT OF GUN 30
21. THE EFFECT OF SHORTENED BARRELS ON THE FIT OF A GUN 30
22. THE FIT OF OVER AND UNDER GUNS . . . 31
23. CHAMBERLESS GUNS 32
24. JAMMED CARTRIDGES 33
25. BARRELS GOING OFF TOGETHER 34
26. EFFICIENCY OF SAFETY CATCHES 35

SECTION PAGE
27. Comparison between 12, 16 and 20 Bores . 35
28. Relative Powers of 12 and 16 Bores . . 36
29. Comparative Powers of 12, 16 and 20 Bores 37
30. "Hard Shooting" Powers of Different Guns 38
31. Strength of Striker Blow 39
32. The Effect of Oil in a Barrel on Pattern or Grouping 39
33. Effect of Obstruction in a Barrel . . 40
34. Oil as an Obstruction in the Bore . . 42
35. Effect of Obstruction of the Muzzle of a Shotgun 42
36. Damage Caused by Obstruction in the Bore 43
37. The Effect of Oil in Chambers . . . 44
38. Bruised Second Finger 45
39. Remedy for Bruised Cheek 46
40. Gun Headache 47
41. Principle of the "Low Velocity Load" . 48
42. Fully Crimped Turnover 50
43. Use of "Perfect" or "Thin Brass" Cartridges in Ordinary Guns . . . 51
44. All-Metal Cartridges in Ordinary Guns . 52
45. The 2-inch 12-bore Cartridge . . . 52
46. Short Cartridges in Long Chambers . . 53
47. 2¾-inch Cartridges in 2½-inch Guns . . 54
48. "Snap" Shooting 55
49. Forward Allowance 55
50. Forward Allowance at Long Range . . 56
51. Shot Velocity and Forward Allowance . 57
52. High Velocity Loads and Forward Allowance 58
53. Relative Efficiency of Horizontal and Vertical Shots 59
54. Optimum Ratio between Length and Diameter of Shot Charge 59
55. Effect of Using Different Shotgun Powders 61
56. Bulk Powders 62
57. Classification of Shotgun Powders . . 62

SECTION PAGE
58. Fibrous Shotgun Powders 63
59. Gelatinised Shotgun Powders . . . 63
60. "Progressive" Powders 64
61. Progressive Shotgun Powders . . . 65
62. Recoil given by Different Powders . . 66
63. "Quickness" of Different Shotgun Powders 67
64. Caps and Powders 68
65. Large Continental Caps 69
66. Importance of Good Wadding . . . 69
67. Cork Wads 70
68. Air-cushion Wads 71
69. Constant Volume Loading 71
70. Gastight Cases 72
71. Wet Cartridges 73
72. Shotgun Cartridges and Weather . . 74
73. Storage of Cartridges 75
74. Shotgun Cartridges in Extreme Cold . . 76
75. The Best Shotgun Powder for Hot Climates 77
76. "Not for Ball" 77
77. Nitro-Proof Charge for Shotguns . . 79
78. Safety Provided by Proof 79
79. The Effect of Wind on Shot Pellets . . 81
80. The Effect of Wind on Different Sizes of Shot 81
81. Penetrative Powers of Large and Small Shot 81
82. Spread of the Shot Charge I 83
83. Spread of the Shot Charge II 83
84. Length of Shot Column at 40 Yards . . 83
85. Effect of Swing on the Flight of the Shot Charge 84
86. Best Shot Sizes 85
87. Shot Size and Pattern 86
88. Drop and Chilled Shot 86
89. Mould Shot 88
90. Meaning of Letters used to describe Shot Sizes 88
91. Plated Shot 88

SECTION PAGE
92. TEST FOR PENETRATION 89
93. PRESSURE AND VELOCITY 90
94. THE EFFECT OF AIR RESISTANCE ON DIFFERENT MUZZLE VELOCITIES 91
95. EFFECT OF SHOOTER'S WEIGHT ON VELOCITY . 92
96. EFFECT OF REDUCTION OF SHOT CHARGE ON VELOCITY 92
97. THE EXTREME KILLING RANGE OF AN ORDINARY 12-BORE 93
98. EXTREME RANGE OF 12-BORE SHOTGUNS . . 93
99. REMAINING VELOCITY OF A PROJECTILE FIRED VERTICALLY 94
100. TERMINAL VELOCITY.—I 94
101. TERMINAL VELOCITY.—II. 96
102. CAUSES OF MIS-FIRES 97
103. RUSTING UNDER THE RIB 97
104. PITTING IN SHOTGUN BARRELS 98
105. CLEANING A GUN AFTER A WET DAY . . 99
106. STORING A GUN 101
107. COMPRESSION OF ACTION SPRINGS . . . 101
108. DETECTION OF LOOSE ACTIONS 102
109. DENTS IN SHOTGUN BARRELS 103
110. DENTS IN GUN BARRELS 104
111. PRESERVATION OF COLOUR OF LOCK PLATES . 105
112. BLUEING OF BARRELS AND ACTIONS . . . 105
113. PULL-THROUGHS IN SHOTGUNS 107
114. WIRE BRUSHES FOR CLEANING SHOTGUNS . . 107
115. LEADING IN SHOTGUN BARRELS 108
116. NON-RUSTING ·22 CARTRIDGES 109
117. NON-RUSTING CENTRAL-FIRE CAPS . . . 109
118. CLEANING FIREARMS WITH WATER . . . 111
119. REMOVAL OF METALLIC FOULING FROM RIFLES . 111
120. CLEANING OF RIFLES AFTER FIRING "NON-FOULING" BULLETS 112
121. NECESSITY FOR CLEANING RIFLES WITH WATER . 113
122. MEANING OF "JUMP" AND "FLIP" . . . 114
123. MEASUREMENT OF FLIP 115

SECTION PAGE
124. ALTERATION IN A RIFLE'S ELEVATION . . . 116
125. RESTING A RIFLE ON A HARD SUPPORT . . . 116
126. COMPENSATION IN RIFLES 117
127. "MEAN POINT OF IMPACT" 118
128. THE EFFECT OF WIND ON A BULLET'S FLIGHT . 119
129. THE COMPARATIVE "QUICKNESS" OF BOLT ACTIONS AND HAMMER OR HAMMERLESS ACTIONS . 120
130. THE "REGULATING" OF DOUBLE-BARRELLED RIFLES 121
131. ACCURACY OF DOUBLE-BARRELLED RIFLES . . 122
132. SIGHTING OF RIFLES AT HIGH ALTITUDES . . 123
133. THE "LEAD" IN THE BARREL 125
134. STREAM-LINE BULLETS 125
135. STREAM-LINE BULLETS 125
136. STREAM-LINE BULLETS 126
137. BALLISTICS AND ACCURACY OF DIFFERENT LENGTHS OF RIFLE BARRELS 127
138. THE FIRST SHOT FROM A CLEAN RIFLE BARREL . 128
139. RICHOCHETS OF BULLETS OFF WATER . . 129
140. THE MAUSER ACTION 130
141. DESIGNATIONS OF AMERICAN RIFLE CARTRIDGES . 130
142. TAKE-DOWN MODEL SPORTING RIFLES . . 131
143. SILENCERS 132
144. DRIFT 134
145. ADVANTAGES OF NITRO-CELLULOSE POWDER OVER CORDITE 134
146. DISADVANTAGES OF NITRO-CELLULOSE POWDERS . 135
147. "LETHAL" AND "CONTRACTILE" BULLETS FOR BIG GAME 136
148. IMPROVISED SHOTGUN PROJECTILES . . . 137
149. RIFLING AND BULLET STABILITY . . . 138
150. AN OLD PROBLEM.—I 139
151. AN OLD PROBLEM.—II 140
152. BALLISTIC COEFFICIENT 141
153. COEFFICIENT OF STEADINESS AND BALLISTIC COEFFICIENT 142

The Sizes of Shotguns

Question 1.—*How are shotguns measured for size? Or, in other words, what exactly is the meaning of the terms, "Twelve-Bore," "Sixteen-Bore," etc.?*

Answer.—The method of indicating the size of a shotgun is very old and goes back to the time of muzzle-loading cannon. A cannon which fired a solid round shot of twelve pounds was described as a "Twelve Pounder," and so for other sizes. Similarly, smooth bore muskets and guns were known by the weights of bullets which they fired. Such bullets were always made of lead and were spherical in shape. The weights of the bullets were sometimes given in ounces, but more often by the number of bullets which went to the pound. For example, a 2-oz. spherical bullet of solid lead was a No. 8, since eight such bullets made up a pound weight; a 1-oz. spherical lead bullet was a No. 16, because sixteen such bullets weighed a pound; and so on. Just as the cannon were known by the weights of their shot, so small arms became known by the weights of their bullets, and one which fired a No. 8 bullet was universally called a No. 8 gun. This system of measuring calibres of both cannon and rifles was abandoned with the introduction of rifled breech-loaders which fired projectiles of far greater length than diameter, and both then became known by the actual diameter of the bore in inches, or fractions of an inch; e.g., 4-inch, 6-inch, 12-inch and 15-inch guns, and ·303, ·400, etc., rifles. It is a fact, however, that certain guns are still designated by the approximate weight of their projectiles, for instance, the 25-pounder and 6-pounder, but in these cases the appellation is no indication of the size of the bore.

In the case of shotguns, however, there was no fundamental change in the type of projectile used and so the old system of gauging has survived. It will, accordingly, be realised that a 12-bore is a gun of such a size that twelve spherical bullets of solid lead, and of diameter the same as the diameter of the bore, would weigh exactly one pound. Similarly, a 16-bore is a gun with a barrel of such a size that sixteen spherical balls of pure lead, each exactly fitting the bore, would go to a pound. It will be appreciated that the bigger the actual number denoting the gauge the smaller is the size of the bore.

The Patterns of 12, 16 and 20 Bores at Different Ranges

Question 2.—*What are the comparative dispersions of 12, 16 and 20 bores at different ranges when the same degree of choke is used in each case? Or, in other words, what difference is there between the diameters of the total spread of the shot charge at different ranges in the case of 12, 16 and 20 bores?*

Answer.—The diameter of the total spread of the shot charge is, for all practical purposes, the same for 12, 16 and 20 bores when the same degree of choke is used in each case. For example, the diameter of the total spread of the charge from a full-choke 12-, 16- or 20-bore is 30 inches at 33 yards, while the total spread of the charge from an improved cylinder 12-, 16- or 20-bore has the same diameter at 23 yards. The dispersion is in fact, for all practical purposes, the same irrespective of the size of the bore, and depends on the amount of choke.

Improved Cylinders

Question 3.—*What exactly is meant by an "Improved Cylinder"?*

Answer.—An "Improved Cylinder" is really a very slight choke and is a constriction of from 3 to 5 thousandths of an inch in the diameter of the bore at the actual muzzle of the barrel. Of course this constriction is not made in the form of a sudden step. It is a gradual taper or cone of $\frac{1}{4}$ to $\frac{3}{8}$ inch in length. Some gunmakers enlarge or " recess " the bore immediately behind the rear end of the cone, and this recess may extend for 6 inches down the barrel with a maximum enlargement in diameter of 3 thousandths of an inch.

Cartwheel Patterns

Question 4.—*We all know that cartwheel patterns—that is a pattern with an exceptionally wide spread and no pellets in the centre—are a veritable curse. What is the cause and is there any absolute cure?*

Answer.—The true cause of cartwheel patterns was for many years a matter of conjecture, but the generally accepted theory was that there were two factors which were, in all probability, the chief root causes of the trouble. These were the inefficiency of the wadding between the powder and shot charges which permitted some gas to escape into the shot charge and so scatter it ; and a wad being caught up in the shot charge immediately after the exit from the muzzle which broke up the normal cohesion of the pellets.

The introduction of the crimp turnover without any over-shot wad proved to result in patterns of greater density in the same barrel while cartwheel patterns were found to be completely eliminated.

This tended to confirm the belief that the cause of cartwheel patterns was the over-shot wad being caught up in the body of the shot charge immediately after the exit of the latter from the muzzle, and the greater the degree of choke the less the risk of the over-shot wad being thus caught. The final confirmation was given by a wonderful series of spark photographs taken in America which clearly showed how the over-shot wad was sometimes caught up by the shot charge and when this occurred the result was a cartwheel pattern.

So the cause of the cartwheel is basically the presence of an over-shot wad, and the crimp closure is a complete and absolute cure since with this method of sealing no over-shot wad is used, the end of the cartridge case being crimped over and in.

Pattern Given by Full Choke

Question 5.—*If the choking of a gun is increased from 70 per cent patterns to, say, 80 per cent patterns by means of the actual choke, and not by lowering the ballistics of the charge, does the velocity of the pellets suffer in consequence of the check given to the charge by the extra choke? When gunmakers have been asked, some decline to make a choke to give more than 70 per cent patterns, while others say they will bore guns to give 80 per cent patterns if desired. Can they do this with cartridges developing standard ballistics?*

Answer.—In the case of a 12-bore a full choke means a constriction near the muzzle of 40 thousandths of an inch. This is the maximum constriction which is used, and no full choke can be bored to give patterns regularly of much more than 70 per cent provided the cartridges develop standard ballistics, or about 75 per cent when cartridges with fully crimped turnovers are used. If the ballistics are lowered it is possible to obtain patterns as dense as 80 per cent. In America many guns are bored very wide in the bore, with the result that the ballistics of the cartridges are lowered, and by this means very dense choke patterns are obtained. In England this system cannot be used on account of the Proof rules. At the same time it should be remembered that a reduction in velocity need not result in any loss in penetration when large sizes of shot are used. This is because large shot retains its original velocity much better than small shot, and consequently at long sporting ranges the actual striking velocity of the large shot may easily be higher than that of the small, even though the muzzle velocity of the small shot was decidedly higher.

Position of "Choke" in a Barrel

Question 6.—*Where exactly does the "choke" occur in a barrel?*

Answer.—"Choke" is a constriction in the bore of a gun varying from 5 to 40 thousandths of an inch in the case of a 12-bore. When less than 5 thousandths it is known as "improved cylinder." This constriction is made in the form of a taper or cone which varies in length from ¼ inch to ⅞ inch, the more the constriction the greater being the length of the cone. The distance of the head, or front end, of the cone may be anything between ¼ inch to 1¼ inches from the muzzle. Generally this distance is greater when the choke is greater, although gunmakers vary in their ideas as to the most suitable combination for the length of the cone of the choke and that of the parallel between the head of the cone and the muzzle.

Effect of Choke on Velocity

Question 7.—*Does choke in a barrel have any effect on the velocity of the shot charge?*

Answer.—In actual fact the effect of choke on the velocity of the shot charge is twofold. First, since it is really a constriction in the bore just behind the muzzle, it checks the velocity of the shot charge slightly and so the actual muzzle velocity from a choke barrel is somewhat less than that from a true cylinder barrel, the reduction depending on the degree of choke.

Secondly, the effect of the choke is to keep the pellets of the shot charge together so that it moves forwards through the air almost like a single projectile for a short distance, and the result is that air resistance is reduced during the early stages of the shot's flight. This means that the shot charge retains its initial velocity better, with the result that the average velocity over the first 20 yards is slightly higher than that given by a true cylinder barrel in spite of the slight check at the muzzle.

This increase, however, is so slight that it has no effect in actual practice and the most that can be said is that a full choke has a slight tendency to give a very small increase in velocity in comparison with a true cylinder.

For all practical purposes of ordinary sport it can be assumed that the choke in a gun makes no noticeable difference.

Possibility of Widening the Pattern of a Full Choke

Question 8.—*Is it possible to widen the pattern given by a full-choke gun by using cartridges in which the shot charges have been loaded in the cases in two or three sections with a thin card wad between each section of shot?*

Answer.—The pattern is certainly widened by this method of loading, but the results obtained are so irregular and uncertain that they cannot be depended on and so it is not to be recommended.

Light-weight 12 Bores

Question 9.—*What is the lightest possible weight for a 12-bore shotgun fitted with 28-inch barrels?*

Answer.—The deciding factor is recoil, and if cartridges loaded with ordinary standard charges are to be used a gun lighter than 6 lb. 4 oz. is not to be recommended, because the recoil developed by standard cartridges when fired in a gun lighter than this weight is too severe for the majority of shooters. It is possible to build a gun as light as 6 lb. or even less, which is perfectly safe, but the recoil would be excessive unless light shot cartridges were used.

Recoil Developed in Short-Barrelled Guns

Question 10.—*In reply to Question 9 it was stated when ordinary standard cartridges are fired in a 12-bore gun which weighs less than 6 lb. 4 oz. the recoil is excessive. I was recently trying a 12-bore gun fitted with 25-inch barrels which weighed only 6 lb., and did not notice any severe recoil. What is the explanation?*

Answer.—Recoil is really the backward momentum of the gun, and this is exactly equal to the forward momenta of the shot charge, wads and powder gases. These forward momenta are dependent on the total weight of the ejecta (i.e., the shot charge, wads and powder gases) and the velocity with which they leave the muzzle. If either the weights or the muzzle velocity is reduced, the forward momenta are reduced, which means the recoil tends to be reduced, but not to the extent which would be expected. This is probably because the velocity with which the powder gases leave the muzzle is higher in comparison with the muzzle velocity of the shot charge in the case of a 25-inch barrel than one of 30 inches, while the intermediate lengths give proportional results. So, although there is a reduction due to the shorter barrels, it is in practice not so great as theory would suggest.

Another contributory reason which is often present as well is that the cartridges usually loaded by gunmakers for use in these very light guns are loaded with light shot charges (1 oz.) while the velocities are also lower than standard. The reduction in the weight of the shot charge and the muzzle velocity results in a light recoil.

The Best Length of Barrels for Shotguns

Question 11.—*What is the best length of barrels for shotguns? Is it true that very short barrels give more satisfactory results than formerly on account of improvements in modern powders?*

Answer.—There is no general best length of barrels. The best length of barrels for any individual is the length with which he finds he can shoot best. Some men find they can shoot better with short barrels while others can only shoot with long ones. It is just as much a matter of personal individuality as the length of stock. There is nothing new in short barrels, for 25-inch barrels have been in constant use for at least sixty years, but the majority of shooters have seemed to prefer something longer. Barrels of 25 inches will prove just as killing as those of 30 inches, because the differences in the velocities developed are negligible at sporting ranges irrespective of what they may be at the muzzle.

The improvements in modern powders have nothing to do with the comparative efficiency of short and long barrels. This comparative efficiency is the same, for all practical purposes, as it was sixty years ago.

Report from Different Lengths of Barrels

Question 12.—*A friend of mine has a 12-bore gun with 25-inch barrels. We have been told by others shooting with us that the reports made by our respective guns—mine has*

30-inch barrels—are quite different. At first we attributed this to the different cartridges we were using but we have been told that the difference is just as pronounced when we were both using the same cartridges, because we tried this to find out if the difference in report was due to the cartridges or not. Can the length of barrel effect the noise of the report?

Answer.—Most certainly. It is a well-known and established fact that in any firearms the noise of the report is increased by shortening the barrel, provided the same cartridges are used.

This is due to the fact that the gas pressure in the bore decreases as the distance from the breech increases. Consequently the gas pressure just inside the muzzle of any barrel will be higher the nearer the muzzle is to the breech—that is in a shorter barrel.

This in turn means that the shorter the barrel the more pronounced the muzzle blast, which results in a louder report.

The Possibility of Shortening Shotgun Barrels

Question 13.—*My gun has 30-inch barrels, the right improved cylinder and the left half-choke. I want to try somewhat shorter barrels. If I have 2 inches cut off the present barrels, will it affect their shooting?*

Answer.—If 2 inches are cut off improved-cylinder or choke barrels all the constriction at the muzzle in both cases will be removed, and consequently the shooting will be spoiled. It is possible, however, for a skilled gunmaker to separate the barrels for some distance at the muzzle end after a couple of inches have been removed, and then to swedge the ends of the shortened barrels down so as to make fresh constrictions. By this means it is possible to put choke into a true cylinder barrel, but the work is highly skilled and therefore expensive, while the results are not always certain. It is almost always better to buy a new pair of barrels than to shorten old ones.

Weight of Trigger Pulls in Shotguns

Question 14.—*What are the normal weights for the trigger pulls in an ordinary double-barrelled 12-bore shotgun? Have gunmakers any standard if the pull-off is not specified when a new gun or guns are ordered?*

Answer.—There is no recognised standard pull, but generally the trigger of the right barrel has a pull of from 3½ lb. to 4 lb., and that of the left barrel one of from 4 lb. to 4½ lb.

Relative Advantages of Side-Lock and Box-lock Actions

Question 15.—*What are the real, as opposed to the fashionable, advantages of the side-lock hammerless ejector over other types? Is the side-lock gun essentially a better gun than the box-lock, and has not the latter type of action any advantages over the side-lock?*

Answer.—Weight for weight a side-lock action is stronger than a box-lock because the action is not cut away in the middle in order to make room for the locks. It is thus possible to build a light side-lock gun without any top extension such as is generally considered necessary for box-lock actions, even though in actual practice this top extension is not so serviceable as it is in theory.

It is also possible to obtain better and more regular trigger pulls with a side-lock, which is a very important point.

On the other hand, box-lock guns are slightly more weatherproof than side-locks ; and they are simpler, and therefore, cheaper, to build. Consequently a higher standard of workmanship is possible in a moderate-priced box-lock gun than in a side-lock which costs the same, because there are not so many limbs to make in the box-lock.

Comparative Quickness of Different Types of Locks

Question 16.—*What is the difference in the times which elapse between the pulling of the trigger and the striking of the cap in the case of a hammer-gun, a hammerless side-lock gun and a hammerless box-lock gun, good quality locks being referred to in each case ? Or, in other words, which is the quickest type of action ?*

Answer.—The time which elapses between the pulling of the trigger and the striking of the cap depends on (1) the strength of the main spring, and (2) the angle through which the hammer falls. In all the types of lock mentioned in the query these two factors are practically identical. Consequently all are equally quick.

Single Trigger Action

Question 17.—*I have a very good quality gun which fits me perfectly and of which I am very fond. I am shortly going abroad and have been thinking of having the action altered to a single trigger. Is this to be recommended or not ?*

Answer.—There are two advantages of a single trigger which are usually put forward but which are probably more theoretical than actual. These are that the fit of the gun is exactly the same for both barrels and that both barrels can be fired one after the other more quickly. But in spite of the claims made by the admirers of single triggers it is somewhat doubtful if these two advantages are really sufficiently pronounced as to be noticeable. But by far the greatest advantage is the ability a single trigger confers to make it possible to shoot in gloves. For some shooters this can be a very great boon and help in cold weather.

It must be remembered that the cost of converting to a single trigger action will be considerable, but quite apart from this there is the undisputed fact that all single trigger mechanisms must introduce a complication, and although it is also a fact that many modern single triggers are wonderfully reliable they cannot be quite so certain as an ordinary double trigger action simply because of the inevitable complication. Further, in both India and Africa it is doubtful whether any gunsmith could be found who would be able to repair the mechanism if it ever did happen to go wrong, and you would most probably have to send the gun to England for repair.

Weights of Gun Stocks

Question 18.—*Is it true that the weight of a best quality gun stock does not depend entirely upon its length? I have recently acquired a second-hand highest grade gun by one of the leading makers which weighs 6 lb. 9 oz., fitted with 29-inch barrels and a 13-inch stock. I need a 15-inch stock, and had the existing stock lengthened. The gun now weighs 6 lb. 12 oz. Could it be re-stocked with a 15-inch stock so as to weigh 6 lb. 9 oz.?*

Answer.—The weight of a best-grade gun stock does not depend entirely upon its length. Stocks are bored out to varying degrees and sometimes extra weight is added so as to obtain a perfect balance. But the wood which is used varies appreciably in density and weight. It is quite possible to select two pieces of wood, both of which are perfectly seasoned, to make the same stock, but one of which weighs several ounces less than the other.

It should be quite possible to re-stock the gun in question with a carefully selected 15-inch stock so as to retain perfect balance and keep the total weight of the gun down to 6 lb. 10 oz., if not 6 lb. 9 oz.

Measurements of a Gun Stock

Question 19.—*Is it possible to send a gunmaker measurements from a gun which fits well so as to enable him to copy it without actually having the gun in his possession ?*

Answer.—A gun made from measurements sent by post cannot be relied upon as an exact copy in every case although such minor differences as may exist can usually be altered easily when the original gun comes to hand. There are three features of a stock which must be considered when sending a gunmaker measurements, namely, bend, length and cast.

Bend is measured by placing a long and perfectly straight rod on the rib of the barrels so as to protrude backwards over the stock. The two perpendicular distances from the comb and heel of the stock to this rod give the bend.

Length is obtained by measuring the distances of the heel, the centre and toe of the butt from the middle of the forward trigger.

Cast is very difficult for an amateur to measure correctly and the best course for the shooter to adopt is to give the gunmaker details as to his height, build and chest measurement. If an actual measurement is required the gun should be placed triggers upwards on a flat table in such a position that the centre of the rib coincides exactly with a straight line drawn on the table. Then the distance between this straight line and the foot of a perpendicular dropped to the table from the heel of the butt gives the cast.

Alteration in Fit of Gun

Question 20.—*I am now nearly fifty and find that I miss birds almost regularly which I used to be able to kill cleanly and with confidence. I realise that I am middle-aged, but I can still walk almost as well as ever and am certainly as active as most men of my age, if not more so. I have been advised to have my guns refitted, but surely this should not be necessary. I have shot with them regularly for nearly thirty years and they always seemed to fit me perfectly. Is there any remedy?*

Answer.—It is by no means an unusual experience for a middle-aged man to find that his guns need refitting if they were originally fitted in his youth. With advancing years, not only does the figure tend to fill out and the shoulders become more "set," but it is by no means unusual for the eyes to change in relative strength. The right eye, for example, may continue to be the master eye but it may no longer be so markedly the master as before, in which case the two eyes will share the control of the alignment of the gun to a greater degree than they did formerly.

In these circumstances it is obvious that a certain modification of the gun may become necessary in order to allow the shooter to use it with the greatest advantage, and your experience is by no means uncommon, let alone approaching the unique.

The Effect of Shortened Barrels on the Fit of a Gun

Question 21.—*I had a favourite old gun which fitted me perfectly and with which I shot successfully for many years. As it was rather heavy I thought I would have a pair of 25-inch barrels fitted to it as well as the original 30-inch pair.*

This was done, but on trying the new barrels I found I missed birds which I felt sure I would have got with the old barrels, and so I went to a shooting school. There the instructor told me that I was shooting high with the short barrels, although I shot normally with the old ones. This cannot be due to the fit of the gun because the stock was the same in both cases. Is there any scientific explanation, or was it just an accident? It has occurred so consistently that an accident seems unlikely, but I can see no cause for the change.

Answer.—The explanation is almost certainly to be found in the difference in the flip of the two pairs of barrels. Short barrels are stiffer and so they do not develop the same degree of downward flip as do long barrels, and it is probable that the 30-inch barrels in this particular case gave a bigger downward flip than usual. The result of this would be a tendency to shoot low, and this tendency was counteracted when the gun was originally built by the fit of the stock.

But when the new short barrels were fitted the downward throw produced by the flip was greatly reduced, and consequently the stock would need a greater degree of bend in order to give the shooter the same results as were obtained with the old barrels.

The Fit of Over and Under Guns

Question 22.—*I have ordered a pair of Over and Under guns as I prefer the grip on this type of gun, and I sent one of my old guns (with ordinary horizontal barrels), which fits me perfectly, as a pattern for the stocks. But the gunmaker says that this is not sufficient and wants me to be refitted for the new guns because Over and Under guns need different fitting from ordinary guns. Is this a fact, and if so, why?*

Answer.—The barrels of an Over and Under gun are obviously far more rigid vertically than are those of a gun with barrels side by side. Consequently Over and Under guns develop considerably less downward flip than do guns of the ordinary type. On this account they show a marked tendency to shoot higher than ordinary guns, and to overcome this tendency the stocks usually require more bend, and so it is always better to be refitted in these circumstances.

Chamberless Guns

Question 23.—*What is meant exactly by a " chamberless gun " ? Also, is it true that this type of boring enables a shooter to use much heavier shot charges without a corresponding increase in recoil ?*

Answer.—A " chamberless gun " is one in which the diameter of the bore is the same as that of the chamber. Thin brass cases only can be used in such guns, for if ordinary paper cases were used the wads would be too small to seal the bore during the passage of the shot charge down the barrel. Owing to the absence of any form of chamber cone brass cases of different lengths can be used with equal efficiency, and consequently different loads can be fired effectively from the same barrel. The very fact, however, that thin brass cases only can be used must prevent such guns from ever coming into use for general shooting, but for wildfowling they are certainly excellent. They owe their development entirely to the late Dr. C. J. Heath, a President of the Wildfowlers' Association, who deserved the greatest credit for his initiative in producing such a suitable and practical weapon.

Very heavy shot charges of 2 oz. and over have been used in 12-bore chamberless guns which weigh as little as 8½ lb., without any severe recoil being noticed, and this absence of recoil has been explained by the fact that there are no chamber cones. This is incorrect. The true explanation is that these heavy shot charges are always used in conjunction with abnormally low powder charges with the result that the muzzle velocity of the shot charge is from 300 to 400 f.s. lower than that normally developed in an ordinary 12-bore. There is, however, no loss in killing power because very large shot (BB) is invariably used. This large shot retains its original velocity far better than small sizes owing to its greater ability to overcome air resistance, and possesses sufficient striking velocity, even at extreme ranges, to kill cleanly. The disadvantage of large shot, namely, the open pattern, due to the small number of pellets in the charge, is overcome by the use of the abnormally heavy charges already mentioned.

Recoil is entirely a question of the momentum of the ejecta (shot, wads and powder gases) on their leaving the muzzle, which depends on their combined weights and velocity. A reduction in velocity enables the weight to be increased without any increase in recoil.

Jammed Cartridges

Question 24.—*On returning from a very wet day on the moor I found, on reaching the lodge, that the cartridges were jammed so tightly that the primary extraction would not move them to any appreciable extent. They had both been in the gun about half an hour. I fired them off, but this had no effect so far as the possibility of moving the cartridges was concerned, and I could not open the gun more than a fraction of an inch. Consequently a hand extractor could not be used, and since it was not possible to open the breech the ejector springs were in action, so the fore-end could not be taken off or the barrels removed.*

Finally I made an attempt to force the primary extraction with the result that one of the extractor heads broke, thus *putting the gun out of action until a new extractor came from the makers.*

What was the proper course to have adopted?

Answer.—After the gun had been fired the fore-end should have been removed and the barrels taken apart from the stock, when the fired cases could have been pushed out with a cleaning rod.

No harm can be done by taking a gun to pieces after firing and before opening it. The ejector hammers do not fall until the gun is opened and the cartridge cases have been ejected, consequently the ejector springs are in a state of compression if the fore-end is removed from the closed gun whether the gun has been fired or not.

Barrels Going Off Together

Question 25.—*It sometimes happens that I fire both barrels of my gun simultaneously without intending to do so. Does this damage or strain the gun, and what is the cause of my making the gun go off like this?*

Answer.—Both barrels of a gun cannot be fired absolutely simultaneously because the second is fired as the result of the firing of the first. Nevertheless the two barrels go off with such a short interval of time between them that they appear to be fired simultaneously. There is no doubt that this double discharge imposes an additional strain on the action; and if it were to occur frequently and the gun were not of best quality the barrels would probably be lifted slightly from the face of the action, even if more serious damage did not result.

There is no single cause for the apparent simultaneous firing of both barrels, but the commonest causes are: (1) the trigger of the left barrel is too light, with the result that the lock of the left barrel is jarred off by the explosion of the firing of the right; (2) the trigger of the left barrel protrudes slightly to the right (in the case of a man firing from the right shoulder), with the result that it is caught by the trigger finger after the first barrel is fired; (3) the stock of the gun is too long for the shooter, with the result that the trigger finger is involuntarily slipped back on to the trigger of the left barrel.

Efficiency of Safety Catches

Question 26.—*When one slips the safety catch of a gun to the "Safe" position, is the gun really safe or can it be jarred off by a fall or knock? I have been told that the action of slipping the safety catch backwards and forwards actually uncocks and recocks the hammers. Is this so?*

Answer.—The safety catch on a hammerless gun is entirely independent of the hammers, and has nothing whatever to do with the cocking or uncocking of the locks. The safety catch merely acts as a bolt on the triggers, and when it is in the "Safe" position it holds the triggers firm and prevents them from being operated in any way. But this does not mean that the gun is really safe, as it is quite possible for a gun to be jarred off by a fall or blow even when the triggers are locked by the safety catch, and this possibility is more pronounced in guns with very light trigger pulls. It is true that the intercepting safety sears should, theoretically, always prevent the hammers from falling unless the triggers are actually pulled. But unhappily this theoretical automatic safety device does not always work in actual practice, and there have been many instances of guns jarring off, even when the safety catches have been put to "Safe."

Comparison between 12, 16 and 20 Bores

Question 27.—*Given that the dispersions of 12, 16 and 20 bores are the same at any given range when the guns are bored* *with the same degree of choke, as was stated in Question 2, then, provided the range be such as will give the necessary number of pellets in the killing circle, is one handicapped in any way by using the smaller bore? That is, provided one cuts one's range down in the case of the smaller bores, is there any greater difficulty in killing game within this range than with a larger bore? Or, to put the question in yet another way, is it more difficult to shoot with small bores, or is one's killing range merely curtailed?*

Answer.—Provided the different sizes of guns are all bored with the same degree of choke it is no more difficult to shoot with a small bore than a large. The only handicap is loss in killing range. The reason why small bores are generally rather more difficult to use effectively than larger bores is that gunmakers bore them more fully choked in order to overcome the loss in killing range.

Relative Powers of 12 and 16 Bores

Question 28.—*Is it a fact or not that a 12-bore shooting 1 oz. and standard powder charge will have greater velocity and striking energy (penetration) than a 16-bore regulated for the standard powder charge and ⅞ oz. of shot?*

Answer.—For all practical purposes of sport the effective velocities developed by the 12 and 16 bores firing the loads specified above are the same, provided the same size of shot is used in both cases. Consequently the penetration possessed at any given range by an individual pellet from either gun is the same. The 12-bore has the advantage, however, because it throws a denser pattern owing to its heavier shot charge, provided both guns are bored with the same amount of choke. If the 16-bore is more fully choked so as to give the same pattern as the 12-bore, shooting will be more difficult at close and medium ranges on account of the smaller spread of shot.

When both guns are bored with the same amount of choke a size larger shot may be used in the 12-bore without lowering the density of the pattern below that of the 16-bore. For example, No. 5½ can be used in the 12-bore and will give exactly the same pattern as No. 6 in the 16-bore because the shot charge is heavier. No. 5½ retains its velocity slightly better than No. 6, and so at any given range the striking velocity of No. 5½ will be somewhat greater than that of No. 6, which must give a slight advantage to the 12-bore in penetration, although this advantage would be almost negligible in actual practice.

Comparative Powers of 12, 16 and 20 Bores

Question 29.—*What is the true comparison between the respective merits of 12, 16 and 20 bores? Is it true that the pattern, penetration and range of the 16 and 20 are equal to that of the 12, but owing to the smaller shot charge the killing circle is reduced in size? What is the actual difference in the killing circle of the three sizes? Assuming the all-round efficiency of the 12 to be 100 per cent what figures would represent the others?*

Answer.—The only true method of making a comparison between 12, 16 and 20 bores, or between bores of any other sizes, is by comparing the actual weights of the shot charges fired by the different bores. For all practical purposes of sport the velocities are the same whatever size of gun is used, and consequently the effective range and killing power is dependent on the pattern. Provided the same size of shot is used in each case, the pattern depends on (1) the weight of the shot charge, and (2) the boring of the gun. The standard weights for the shot charges of 12, 16 and 20 bores are 1$\frac{1}{16}$, ⅞ and ¾ oz. of shot, and with these charges the actual patterns in 30-inch circles at 40 yards are the same in the case of an improved cylinder

12-bore, a half-choke 16-bore and a full-choke 20-bore. Consequently when guns of these sizes *and borings* are compared, the patterns, penetration and effective ranges are the same; but the smaller bores are more difficult to shoot with on account of the reduced killing circles due to the amount of choke used in each case. At 25 yards the diameter of the effective spread of the whole charge is approximately 32 inches in the case of an improved cylinder, 26 inches for a half-choke and 21 inches for a full-choke, *whatever size of bore is used.* At 40 yards the corresponding figures are approximately 46 inches, 40 inches, and 34 inches. When 12, 16 and 20 bores are all bored with the same degree of choke, the larger bore is more effective, and if a 12-bore firing $1\frac{1}{16}$ oz. of shot is taken as 100 per cent, the equivalent percentages for 16 and 20 bores will be 82 and 70.

"Hard Shooting" Powers of Different Guns

Question 30.—*I intend ordering a new gun and want to know if there is any truth in the belief that some makes of guns shoot harder than others?*

Answer.—The belief that some guns shoot "harder" than others is quite erroneous. A bird is killed when a shot pellet penetrates some vital spot, and consequently killing power depends on the number of pellets which strike the bird, as the greater this number the greater the chances of hitting some vital organ, provided all these pellets strike the bird with sufficient velocity to ensure penetration.

The number of pellets which strike a bird at any given range is dependent on the boring of the gun, provided cartridges are being used which develop satisfactory ballistics. Consequently a full choke will always be more likely to kill a bird dead at moderately long ranges than an improved cylinder because it gives a denser pattern when other conditions are the same. But a full choke is not suitable for ordinary game shooting in Great Britain.

The striking velocity of the shot pellets is, for all practical purposes, dependent solely on the cartridge and has nothing to do with the gun. Consequently to speak of some individual gun as being a particularly " hard shooting " weapon is quite incorrect. The most important point in any gun is its power of giving evenly distributed and regular patterns when firing cartridges which develop standard ballistics.

Strength of Striker Blow

Question 31.—*In reply to Question 30, it was stated that there is no truth in the belief that some guns shoot " harder " than others. Does not the strength of the striker blow affect the velocity developed, and consequently the penetration ?*

Answer.—Provided that the striker blow is sufficiently strong to result in a proper detonation of the cap, and not cause hang fires, there is no proof that any extra strength of blow produces a more violent explosion. Consequently an increase in the force of the striker blow will have no result on the " hard shooting " powers of a gun.

The Effect of Oil in a Barrel on Pattern or Grouping

Question 32.—*Does a clean and slightly oiled shotgun barrel give a different pattern at 40 yards from what it would give after a cartridge has been fired through it ? If so, why ? Further, why does a shooter with money on himself go to the trouble of firing a cartridge before taking his stand at the live or clay pigeon ?*

Answer.—Regularity of pattern in a shotgun really corresponds to close grouping in a rifle. Both shotguns and rifles are designed and made to give regularity of pattern or close grouping under conditions in which they will actually be used. These conditions entail a certain amount of fouling in the barrels. Consequently it would be useless, even if it were possible, to try to regulate shotguns to give normal patterns from an oily barrel because the barrel would have to be cleaned out and re-oiled before every shot in order to reproduce similar conditions. An oily shotgun barrel gives a greater percentage of abnormal patterns than one which is fouled by a previous shot, just as a shot fired from an oily rifle barrel is frequently not found in the middle of a group made when the barrel is slightly fouled. Generally speaking, oil in the barrel itself results in a more open and scattered pattern, but the exact reason for this is not known. Consequently the shooter who has money on himself will always do best to fire a cartridge through the barrel before taking his stand.

Effect of Obstruction in a Barrel

Question 33.—*I know that an obstruction in either a shotgun or rifle barrel can result in the barrel being bulged or burst when a shot is fired, but will the same result occur when the obstruction only partially seals the bore as when it seals the bore completely? Surely the bulge or burst is caused by the compression of the air between the front of the bullet or shot charge and the obstruction? If this is so an obstruction which only partially seals the bore should do harm. Is this correct or not?*

Answer.—The belief that the barrel of either a rifle or shotgun can only be bulged or burst by the presence of an obstruction in the bore which only partially seals the bore is entirely wrong, and therefore dangerous. Similarly, the belief that any damage caused by an obstruction in the bore is due to the compression of the air between the obstruction and the advancing projectile is also entirely wrong although it is an old belief and dies hard.

A barrel can be either bulged or burst when the bore is only partially sealed by an obstruction, in which case there is no compressed air as the air can obviously escape past the obstruction without any difficulty; and bulges or bursts have frequently been produced experimentally by inserting a bit of tubing in the bore through which the air can easily escape.

The bulge or burst is due to what is termed a " Wave Pressure " and to nothing else. The manner in which such a pressure is produced is explained very fully in Volume III of *The Modern Shotgun*. Briefly, it can be stated that when the advancing projectile (bullet or shot charge and wadding) strikes the obstruction in the bore there is a momentary check in velocity after which the projectile and obstruction move on together up the bore, but with a lower velocity than that possessed by the projectile immediately before the impact. The change in the projectile's velocity results in a wave pressure being developed, and it is this wave pressure which acts radially outwards, that is all round the bore, over a very short length of the bore and causes a bulge all round the circumference of the bore, or even a burst when the pressure is sufficiently intense. Since the wave pressure acts all round the bore the bulge is also circumferential and gives the appearance of a ring on a finger. Hence the name Ring Bulge which is applied to this particular type of damage.

The wave pressure is, of course, developed immediately behind the base of the projectile; but since an appreciable interval of time is required for the wave pressure to develop, the projectile will have advanced a little way before the bulge is formed. Consequently it will be realised that the Ring Bulge is formed at a site immediately behind the base of the projectile but in front of the position of the base of the projectile at the moment of impact.

Oil as an Obstruction in the Bore

Question 34.—*A friend of mine has just had the right barrel of his gun burst about 10 inches from the muzzle. It was the first shot of the day and he is convinced that he left no cleaning material in the bore. I examined the gun very soon after the accident and noticed that there was a lot of thick grease smeared over the inside of the bore of the left barrel. If there was grease in the right barrel could this have caused the burst ?*

Answer.—Most certainly. It is perfectly possible for an accumulation of thick oil or grease in the bore of a gun or rifle or revolver to act as an obstruction and cause a bulge all round the circumference of the outside of the barrel, which looks like a ring on a finger and is consequently known as a Ring Bulge, or an actual burst.

This is one of the reasons why oil or grease should always be removed from the bore of any weapon before firing. A thin smear of thin oil is not likely to create any risk, it is true. But there will always be a point where the condition of comparative safety changes to one of possible risk, and so it is better to play for safety and always wipe out any barrel before firing.

Effect of Obstruction of the Muzzle of a Shotgun

Question 35.—*In the answer to Question 33 it was stated that a bulge or burst will always occur if there is any sort of obstruction in the bore. Out shooting recently a friend scraped the ground with the muzzle of his gun and picked up a little mud at the extreme muzzle of his right barrel. He tried to* *blow it out but failed and so fired a shot to clear the barrel. No bulge of any sort was formed. If an obstruction which only partially seals the bore is so dangerous why was this ?*

Answer.—Your friend was very lucky. It was stated in the Answer to Question 33 that the ring bulge or burst occurs in front of the spot occupied by the base of the projectile at the moment of impact because the Wave Pressure needs an appreciable interval of time to develop. If the rear end of the obstruction is very near the muzzle of the barrel the projectile can have time to leave the muzzle before the wave pressure can develop when this wave pressure is actually produced just outside the muzzle of the barrel, where it cannot do any damage.

It is extremely dangerous to count on this happening and mud or snow which has been picked up accidentally by the muzzle of a gun scraping the ground, or even the wall of a grouse butt, is one of the most common causes of damaged barrels.

Damage Caused by Obstruction in the Bore

Question 36.—*In Answer to Question 35 it was stated that an obstruction at the extreme muzzle end of the barrel will sometimes not result in any ring bulge or burst. Does this mean that when there is an obstruction in the bore which is not at the extreme muzzle end a bulge or burst is inevitable ?*

Answer.—It is safer to assume that it does, but in actual practice the damage due to an obstruction in the bore will vary in degree with the intensity of the wave pressure resulting from the impact of the projectile against this obstruction. This intensity is directly dependent on the amount of change in the velocity before and immediately after the impact, and the amount of change will be governed both by the weight of the obstruction and the velocity of the projectile immediately before the impact. A very heavy obstruction must obviously result in a bigger change in velocity than a very light one ; and the change in velocity is also likely to be greater when the projectile is moving very fast than when it has only just started to travel up the bore.

But the degree of damage for any given intensity of wave pressure will also depend on the strength of the barrel at the point where that wave pressure is developed, that is on the thickness of the wall of the barrel and the elasticity of the steel of which the barrel is made.

If the wave pressure is very slight and the barrel is both thick and of good quality steel it may not be stressed beyond the elastic limit of the steel, in which case the ring bulge will have been formed but will not remain a permanent feature because the wall of the barrel will have resumed its original form owing to its elasticity. But the obstruction must be very light for this to happen, or the barrel very abnormally thick in the case of a shotgun. There are many cases on record of a shotgun barrel having been bulged and even burst by the presence of a card wad in the bore.

So it cannot be emphasised too strongly that no risks should be taken if it is possible to avoid them.

The Effect of Oil in Chambers

Question 37.—*In Question 32 the effect of oil in a barrel on pattern or grouping was considered. No mention, however, was made of the effect of oil in the chambers of guns and rifles. Is it not a fact that an oily chamber results in dangerous pressures ?*

Answer.—The effect of oil in the chamber of either a gun or a rifle has two aspects, namely : (1) the effect on ballistics ; and (2) the effect on the powder pressure on the action. The effect on ballistics in the case of shotguns is nil. In the case of rifles the effect is not great, but it is certainly true that an oily chamber results in slightly higher velocities. It is reasonable, therefore, to suppose that these higher velocities are the result of higher chamber pressures. The exact cause of this increase in ballistics is not definitely known, although various theories have been formulated to explain it. But in any case the actual increase in pressure brought about by this aspect is not very great. The effect produced on the actions of rifles by the increase in powder pressure, however, is very decided. Experiments have been carried out with ·450 3¼-inch cordite cartridges which showed that when the chamber was very greasy the pressure on the action was approximately double that when the chamber was dry. Accordingly it will be seen that for degrees of greasiness of the chamber the pressure on the action will lie between the limits of a perfectly dry chamber and one which is very greasy. It is, accordingly, perfectly correct to state that an oily chamber in a rifle tends to dangerous pressures. In shotguns, however, the state of greasiness of the chambers has practically no effect on the force on the action.

Bruised Second Finger

Question 38.—*I bought a second-hand gun recently which is satisfactory in every way except that the trigger guard bruises the second finger of my right hand. What is this due to, and is there any remedy?*

Answer.—In the great majority of cases a bruised second finger is an indication that the stock of the gun is too short, but other causes may be the comb of the butt being too far forward so that insufficient room is left for the hand on the small of the stock, the trigger guard being badly shaped, or abnormally loose holding of the gun on the part of the shooter. Apart from the lengthening of the stock, the simplest remedy is to remove the screw which holds the rear end of the trigger guard to the small of the stock and then slip an ordinary indiarubber umbrella ring over the end of the guard until it rests in the angle, when the guard can be screwed to the stock again. This type of rubber ring acts as an effective pad and prevents bruising.

Remedy for Bruised Cheek

Question 39.—*I find that I always tend to suffer from a bruised cheek after firing about fifteen to twenty cartridges from my gun although it is a good quality gun and was fitted to me by the maker. Is there any complete remedy?*

Answer.—Generally there is. It is very common for men with pronounced cheek-bones to suffer from a bruised cheek after firing comparatively few shots in quick succession.

The remedy is usually proper fitting of the gun. And you must not forget that practice cartridges provided at a shooting school are often loaded more lightly than ordinary game cartridges and so you might easily not have noticed any trouble when your gun was fitted.

If the stock is eased out very slightly where the contact between the stock and cheek occurs this may quite easily effect a cure. Any competent gunmaker would be able to do the work, and after the stock has been eased only a little you should try some shots in quick succession and if you still notice any bruising a little more wood can be removed. It is better to hollow the stock out very gradually.

In extreme cases so much wood has sometimes to be removed that it is replaced by a leather pad. But this is somewhat unsightly and is seldom necessary.

By far the best plan is first to go to a good shooting school coach who would be able to put matters right very quickly.

You may be banging your face with the stock when you are mounting the gun, and if so the coach would tell you. And it is surprising what a common fault this is.

Gun Headache

Question 40.—*What is the cause of gun headache, and what is the remedy?*

Answer.—The exact cause of gun headache is not understood and probably differs with individuals. Generally speaking, if the shooter is in normal health and his gun fits him properly, it is the result either of severe recoil, or else the combination of recoil and the jar of the explosion.

Recoil is dependent on both the weight of the shot charge and the velocity with which the shot charge leaves the muzzle, and so the usual remedy is to reduce both of these factors by adopting a shot charge of $\frac{15}{16}$ oz. and a powder charge of two to three grains lighter. Very light loads such as this, however, are not always effective against game, and consequently it is usually better first to try a normal powder charge with 1 oz. of shot.

Different powders are also sometimes found to reduce gun headache but there is no hard and fast rule, for a powder which one sportsman declares to cure his gun headache is found by another to be very troublesome, and it is probable that the effect of a change in powder is psychological. If a sportsman suffers seriously from gun headache he should try a lighter load, at first reducing only the shot charge, and then reducing the powder as well, if he is still inconvenienced. A change of powder can also be tried.

The truth is that every sufferer must find out what load suits him best and this he can do only by actual experiment. But he should always remember that his object must be to reduce the recoil.

Principle of the "Low Velocity Load"

Question 41.—*What is the real principle underlying the theory of the "Low Velocity Load"? And are such loads satisfactory in practice?*

Answer.—It is a mistake to believe that what is known as the "Low Velocity Load" is based on theory, for it is actually based on one of the first elementary principles of ballistics, namely the fact that when two spherical balls of different weights are propelled with equal velocity, the larger ball will retain a greater proportion of its original velocity for a greater distance than the smaller.

This, of course, applies to shot pellets just as it did to solid iron cannon balls, and it is a fact that when pellets of No. 4 and No. 6 shot are both propelled with the normal standard velocity adopted for shotgun cartridges, the pellet of No. 4 has a striking velocity at 60 yards almost identically equal to the pellet of No. 6 at 50 yards.

But this is not all, for, as is explained in the answer to Question 81 the capacity for penetration possessed by any individual pellet depends on its weight as well as its velocity. So the pellet of No. 4 scores off the No. 6 in two ways; extra weight and ability to retain a certain velocity at a greater range. In practice the powers of penetration, or effectiveness against game, depend, therefore, on the energy of the pellet. And when No. 4 and No. 6 shot both leave the muzzle of the gun with the same standard velocity the energy of a pellet of No. 4 is almost exactly the same at 60 yards as the energy of a pellet of No. 6 is at 40 yards. And this is one of the reasons why sportsmen very rightly prefer larger shot sizes for long shots.

But the disadvantage of larger shot sizes is that, owing to the heavier weight of the individual pellets, there cannot be so many pellets in the charge. And this must mean a more open and scattered pattern which can easily result in not a single pellet striking a vital spot.

The pattern density can only be increased for any given shot size by using a heavier charge of shot and this means a higher pressure.

If, however, the powder charge is reduced the heavier shot charge can be fired with a normal pressure but the muzzle velocity will not be so high. In practice the muzzle velocity is not measured and the average velocity over the first 20 yards is measured instead. It is a fact that pellets of No. 4 shot propelled with an average velocity over the first 20 yards, which is as much as 100 f.s. lower than the usually accepted standard, possess at 60 yards a striking energy almost identical with that of pellets of No. 6 at 45 yards even when the latter started with the standard velocity, which means that the lower velocity and heavier charge of No 4 has an increased range of effectiveness per pellet of just about 15 yards.

In practice the advantage is not quite so great because the pattern even with the heavier charge of No. 4 is not so dense at 60 yards as that of the normal charge of No. 6 fired at the normal velocity. But when both loads are taken at 40 yards the difference in pattern is not so pronounced and that given by the Low Velocity load of No. 4 is sufficiently dense for comparatively big birds while the powers of penetration possessed by the individual pellets are greater than those of pellets of No. 6 at 30 yards when fired with the normal velocity.

So it will be clear that the Low Velocity load of No. 4 gives an adequate pattern density at 40 yards but much greater powers of penetration than a normal load of No. 6. For small birds this is of no advantage whatever, in fact it is a handicap. But for big birds, such as geese, the advantage is very real. In fact for wild-fowling the Low Velocity principle can be pushed further and with 3-inch 12-bore cases still heavier shot charges can be propelled at still lower velocities, for example shot charges of 1¾ oz. of No. 1 and 2 oz. of BB can be used with "Observed" velocities over the first 20 yards of but 900 and 850 f.s. with absolute safety and greater effect at long ranges than the normal shot charge of but 1½ oz. The recoil is not increased by these heavier loads owing to the greatly reduced muzzle velocities, but penetration at extreme ranges is maintained in a most remarkable degree.

For ordinary game shooting it is doubtful whether the Low Velocity load has any advantage. But for wildfowling its success has been proved beyond doubt.

Fully Crimped Turnover

Question 42.—*Just what are the advantages of the fully crimped turnover instead of the usual rolled turnover and an over-shot card wad?*

Answer.—The complete prevention of cartwheel patterns; the almost complete prevention, even if not absolutely complete, of scattered patterns; and the greatly increased regularity of patterns.

It was explained in the Answer to Question 4 that cartwheel patterns were caused by the over-shot wad getting caught up in the body of the shot charge almost immediately after its exit from the muzzle of the barrel.

The other improvements are also undoubtedly due to the absence of the over-shot card wad.

Another feature of the fully crimped closure is a marked tendency to increase the density of all patterns from all types of boring, and it can be taken as a rough rule that patterns given by cartridges sealed with a fully crimped closure have an all round average "count," or density of about 5 per cent more than those given by similar cartridges with the normal over-shot wad and rolled turnover. This means, for example, that with the crimped cartridges a full choke will give a pattern of about 75 per cent of the total pellets in the charge instead of the normal 70 per cent from a cartridge with an over-shot card wad. On the whole this is probably an advantage, but it must be remembered that in close shots at driven game many shooters often need as wide a pattern as they can get. So although a denser pattern is a great help with long shots it is not always the same help with close shots.

But when all the pros and cons are taken into consideration there is not the slightest doubt that the fully crimped closure is one of the greatest improvements in shotgun cartridges since the introduction of smokeless powders.

Use of "Perfect" or "Thin Brass" Cartridges in Ordinary Guns

Question 43.—*Is it safe to use 12-bore "Perfect" or "Thin Brass" cartridges in any ordinary 12-bore gun? That is a gun chambered for paper-tubed cartridges. It is, of course, assumed that the chamber of the gun is long enough to take the "Perfect" cartridge properly.*

Answer.—It is certainly not safe to use "Perfect" or "Thin Brass" cartridges in a gun chambered for ordinary paper-tubed cartridges even though the length of the chamber is suitable. The walls of "Perfect" or "Thin Brass" cases are appreciably thinner than those of ordinary cases, being of brass instead of paper, and so although the external diameter is the same the internal diameter is larger. The effect of this increased internal diameter enables larger powder and shot charges to be used, while the wads must be of greater diameter. In fact, from the point of view of loading, a 12-bore gun chambered and bored for "Perfect" or "Thin Brass" cases is almost the same as a 10-bore which takes paper cases.

All-Metal Cartridges in Ordinary Guns

Question 44.—*In the Answer to Question 43 it is stated that it is not advisable, if not actually unsafe, to use " Perfect " or " Thin Brass " cases in an ordinary gun chambered for paper cases. How was it, then, that before 1939 the Belgian F.N. All-Metal zinc cartridges were used safely and successfully in ordinary guns chambered for paper cases ?*

Answer.—In the case of the Belgian F.N. zinc cartridges the difficulty was partly overcome by the use of a thinner felt wad, which sealed the bore effectively owing to its larger diameter, and partly by the employment of a special slow burning powder which gave normal chamber and barrel pressures.

The larger diametered wad also had the effect of sealing the forward part of the chamber in front of the short cartridge case and so preventing any escape of gas before the shot charge entered the bore.

The 2-inch 12-Bore Cartridge

Question 45.—*What is the advantage, if any, of the 2-inch 12-bore cartridge which seems to be merely a 16-bore cartridge in a shorter and fatter shape ? I have been told that it gives better patterns than other cartridges. Is this true ? And if so, why ?*

Answer.—The original purpose of this cartridge was to provide an alternative gun and cartridge to the ordinary 20-bore and so remove the well-known danger of intermingled 20-bore and 12-bore cartridges when both sizes are kept in the same room, or house ; and at first the load was,
ll practical purposes, a 20-bore load. But experience
sures tended to be too low to be always
ne gunmakers increased the shot charge

from $\frac{3}{4}$ oz. to $\frac{7}{8}$ oz., thus making it similar in weight of shot to the ordinary 16-bore.

It is perfectly true that the 2-inch 12-bore gun and cartridges do tend to give somewhat closer patterns than those normally obtained when using the same degree of choke and the same weight of shot. The reason may be due partly to the shorter shot column in the bore being more sensitive to the restriction of the choke and partly to the low pressures which the 2-inch 12-bore cartridge invariably gives, even with the $\frac{7}{8}$ oz. shot charge.

Claims have been made that ballistically the 2-inch 12-bore is superior to the ordinary $2\frac{1}{2}$-inch 12-bore and other $2\frac{1}{2}$-inch cartridges because similar velocities are obtained while the pressure in the short cartridge is invariably lower. In other words that the short shot column results in the same velocity being developed for a lower pressure and so with less stress to the gun. Theoretically there is some truth in this argument, but in practice it must be remembered that once the average pressure drops too much there will always be some rounds in which the individual pressures are lower still and may easily be too low to ensure proper combustion of the powder, when very feeble results may be given. There is such a thing as having too low a pressure for practical purposes, and it was for this reason that some gunmakers increased the shot charge from the original $\frac{3}{4}$ oz. to $\frac{7}{8}$ oz.

Short Cartridges in Long Chambers

Question 46.—*Is there any harm or risk in using ordinary $2\frac{1}{2}$-inch 12-bore cartridges in my $2\frac{3}{4}$-inch 12-bore gun?*

Answer.—Provided you take ordinary care in cleaning your gun you need have no fear of any evil effects from using $2\frac{1}{2}$-inch cartridges in $2\frac{3}{4}$-inch chambers. But you must not expect the patterns to be so good or so regular as there will almost certainly be some escape of gas past the wadding before the latter has got past the chamber cone and sealed the bore, and you will be well advised to have your gun patterned first with the short cartridges so as to get some idea of what degree of efficiency you can expect.

Similarly it would be possible to use the short 2-inch paper-tubed 12-bore cartridges in a 2½-inch chamber.

The 2-inch All-Metal cartridges were quite a different matter as the metal cases were much thinner than the paper cases and so the wadding was of greater diameter and prevented any escape of gas even in the chamber. (See also Answer to Question 44.)

2¾-inch Cartridges in 2½-inch Guns

Question 47.—*Quite often when abroad I have found it extremely difficult to buy any 2½-inch 12-bore cartridges locally although it is usually easy to get 2¾-inch cartridges. Is it really dangerous to use 2¾-inch cartridges in a gun chambered for 2½-inch cartridges or is there only some risk of straining the gun? In this case would a few shots matter?*

Answer.—It should be realised quite clearly that it is most dangerous to use 2¾-inch cartridges in a gun chambered only for 2½-inch cartridges, and this fact cannot be emphasised too strongly.

The danger is twofold. First the cartridge is too long to fit into the chamber properly with the result that the front end of the cartridge is forced into the chamber cone. This has an effect similar to a very heavy turnover, which in itself will cause a serious rise in pressure.

Secondly, both the powder and shot charges in the 2¾-inch cartridge are heavier than those in the 2½-inch cartridge, against which the majority of 2½-inch guns are proved. So these increased powder and shot charges will by themselves produce a higher pressure than that for which the gun was built to withstand.

The combination of these two wholly different causes for increased pressure is very dangerous and there have been many accidents due to the use of cartridges too long for the chamber.

It is true that some guns are proved to withstand the normal 2¾-inch pressure, but even with these guns 2¾-inch cartridges should not be used because of the additional increase in pressure due to the forcing of the front end of the cartridge into the chamber cone.

" Snap " Shooting

Question 48.—*I have recently been told that the new way of shooting is by taking almost a " snap shot " at one's bird and that this is what is now taught at the shooting schools. When I was at a London shooting school last year I was taught to bring my gun up on the tail of the bird and swing forward. Is there any advantage in this new method ?*

Answer.—There is no " new " method of shooting. Some men swing quicker on to their birds than others, that is all, and the very quick swingers seem to " snap " their shots. It is true, however, that a very few men do really " snap " their shots and intercept their birds, but so few can do this successfully that this method is hardly ever advocated by an instructor.

Forward Allowance

Question 49.—*I was recently told at a shooting school that the correct way to shoot is to keep your eye on the bird and swing the gun with the bird and press the trigger, and that it is wrong to make any forward allowance, i.e., to swing the* *gun to a position in front of the bird and to press the trigger when the gun is in that position. I have asked one or two people who shoot rather extra well, and they say they always try to shoot in front of the bird, and that it is necessary to make a forward allowance. My instructor said the velocity of the shot was so great that provided the gun was swinging on the bird, no forward allowance was necessary. Which is correct?*

Answer.—A forward allowance is, of course, always necessary, and the shooting school instructor was entirely wrong in his explanation when he stated that the velocity of the shot was so great that it was only necessary to swing "on" the bird. As a matter of actual fact, if a shooter swings "on" the bird and "blots it out with the muzzle of his gun," as shooting school instructors term it, it is not necessary to bother about forward allowance for all shots at moderate ranges, because the very fact that the bird is "blotted out" means that the gun must be pointing ahead of the bird, which gives a forward allowance. If the trigger is then pressed without any check in the swing a kill will probably result.

At long ranges, however, a more decided forward allowance is required and then the shooter will have to swing well through and past the bird and press the trigger without any check in his swing.

Forward Allowance at Long Range

Question 50.—*To estimate correctly the necessary forward allowance when shooting at ranges of from 20 to 40 or 50 yards must be almost impossible. Is it not a fact that at long ranges one points the gun at what looks like a gun's length ahead of the bird and swings forward? Or should one try to throw one's gun 12 feet or more ahead of the bird in the first instance?*

Answer.—It is impossible to give any definite rule, as a method which may help one man may only confuse another. Probably the method which is most generally recommended is to bring the gun up behind the bird, and then swing right through in the direction in which the bird is flying, and finally to pull the trigger without any check in the swing when the gun is pointing well ahead of the bird.

It is impossible to judge any particular number of feet as a forward allowance; but it is useful to know what the approximate forward allowance is at various ranges, as the possession of such knowledge may impress upon one the necessity for swinging well ahead of the bird at long range It is doubtful whether any shooter can tell to a yard, let alone to a foot, what forward allowance he gives. He is merely conscious of swinging well through.

Shot Velocity and Forward Allowance

Question 51.—*Is not shooting rendered much more difficult by the Low Velocity principle owing to the greatly increased forward allowance which must be necessary on a crossing bird?*

Answer.—The question is based on an assumption which is wrong. No "greatly increased forward allowance" is necessary when using a Low Velocity load. The larger shot, as was explained in the Answer to Question 41, maintains its original velocity better than smaller shot, and this means that there is no practical difference in the average times of flight over a given sporting range. At 50 yards, for example, the times of flight of a charge of Low Velocity No. 4 and a Standard Velocity No. 6 are, for all practical purposes, identical.

Of course, when using a very Low Velocity charge of BB at ranges approaching 100 yards the forward allowance on a crossing bird would be terrific: but so it would be with any load or charge, and shots at such extreme ranges are normally only taken at bunches of fowl on the water or a gaggle of geese on a mudflat, or some similar type of target.

High Velocity Loads and Forward Allowance

Question 52.—*The Answer to Question 51 seems to ignore the reduction in forward allowance which can be given by a High Velocity load. Why?*

Answer.—For all practical purposes of sport no effective reduction is given by any High Velocity load.

The actual reduction in forward allowance given by a High Velocity load over the standard for a bird crossing at 40 yards and flying at 40 m.p.h. is *6 inches*. The effective spread of the pattern is 30 inches.

In the case of a bird crossing at *60 m.p.h.* at 50 yards the forward allowance with the standard load is just on *6 yards*, and with the High Velocity load it is almost *5½ yards*. The spread of the pattern is roughly at least *4 feet*. If any sportsman can really believe that a reduction of less than *2 feet* is really material in a total forward allowance of over *5 yards* when the spread of the shot charge is 4 feet he can only be regarded as a definite optimist.

At ranges less than 40 yards the differences in forward allowance are much smaller and can really be forgotten. If any sportsman is missing his birds behind with a standard load he will not hit them in the head with a High Velocity load unless he gives a bigger forward allowance himself, and it should never be forgotten that any check in the swing will make a far bigger effect on the forward allowance than any possible or practical variation in the type of load.

Relative Efficiency of Horizontal and Vertical Shots

Question 53.—*Is the pattern and penetration, when using the same gun and cartridges, as efficient in the case of a shot at a bird right overhead as when a shot is taken at a bird flying at the same level as the shooter's shoulder ?*

Answer.—There was at one time a fairly widespread belief that the pattern of a gun fired vertically was appreciably less dense than when the gun was fired horizontally. But like many widespread beliefs this one was, and is, quite untrue. For all practical purposes of sport there is no difference whatever between the pattern of a gun fired vertically and that of the same gun when fired horizontally.

Details are given in Volume III of *The Modern Shotgun* of a series of experiments which prove this fact conclusively.

Nor is there any practical loss in penetration in the case of a vertical shot due to the fact that gravity acts in the direct line of flight of the pellets. The governing factor in penetration, which is a function of the actual striking velocity at any given range, is the resistance of the air ; this is so overwhelming that all other factors are of secondary importance. The air resistance is obviously the same whether the shot is fired vertically or horizontally, and so the striking velocity and penetration are the same for all practical purposes of sport at any given range.

Optimum Ratio between Length and Diameter of Shot Charge

Question 54.—*Surely there must be a scientific optimum ratio between the length and diameter of the shot charge when in the bore of the gun ? 1 oz. of shot, for example, is used in 12, 16 and 20 bores. This must be wrong as if the 1-oz. charge suits a 20-bore the shot column will be too short for its diameter when used in a 12-bore. My experience has been* *that a 20-bore handles a 1-oz. charge better than a larger gun. Is this experience confirmed by scientific tests?*

Answer.—There are many shooters who prefer smaller bores than 12 using the same shot charge as that of the 12. Usually they base their preference on the fact that the slimmer barrels make handling and shooting easier, and then some go further and maintain that 1 oz. of shot is handled better by a 20-bore than anything larger. This is really like the man who liked whisky and said that it must, therefore, be good for him.

The truth is that there is no theoretical optimum ratio between the length and diameter of the shot column when in the bore. Provided the column is long enough to ensure enough resistance to the expansion of the powder gases in order to enable these gases to develop adequate pressure, there can be no doubt that the shorter the column is in relation to its diameter, the better. It would not be possible, for example, to shoot ½ oz. of shot in a 4-bore, as the column of shot would be too short to offer sufficient resistance, and the pressure would consequently be too weak to permit adequate combustion of the powder. But if we take 1 oz. of shot, as is suggested, there is not the slightest doubt that better results and greater efficiency will be obtained by using it in a 12-bore than in a 20-bore. A 10-bore is probably the limit for satisfactory shooting with a 1-oz. charge, but it is a fact that very good results have been obtained with this charge in 12-bore chamberless guns, which are in reality practically 10-bores.

The longer the column of shot is in relation to its diameter, the greater the number of pellets on the outside of the column which are in contact with the bore, and so the greater the tendency to get a larger number of distorted pellets. Further, the greater the resistance to the powder gases, and so the higher the pressure.

In actual practice perfectly good results can be obtained with 1 oz. of shot in a 20-bore, but in order to obtain these results the barrel must be given more choke than is needed in a 12-bore to give the same pattern density, and the pressure will be higher, which means that the powder charge will not be burning so efficiently.

If the 20-bore barrel were bored with the same degree of choke as the 12-bore the pattern would not usually be so good in the smaller gauge gun.

Effect of Using Different Shotgun Powders

Question 55.—*Shooters are advised always to stick to one brand of powder. Is this because different powders require different forward allowances on crossing birds ? For example, if a shooter fired at a bird with a cartridge loaded with Powder " A " in the belief that it was loaded with Powder " B " (which he always uses), would the position of the bird in the shot pattern be the same as if Powder " B " had been used ?*

Answer.—It is always better to use the same brand of powder and the same charge, both of powder and shot, as those for which the gun was originally regulated by the gunmaker, as such will generally give the most regular patterns. In actual practice, however, there is little difference in the results obtained with different powders, and there is no difference in the velocities developed provided the shot charges are the same in each case. Consequently the necessary forward allowance on a crossing bird is identical when using any reliable brand of powder in cartridges which have been properly loaded, and the position of the bird in the pattern is not affected by the kind of powder used.

The strongest reason for sticking to one kind of powder is a psychological one, as a sportsman will always shoot better when using cartridges in which he has confidence based on long usage, than he will when trying new loads or charges. In the latter case a few misses may lead to doubt in the cartridges and doubt is fatal to good shooting.

Bulk Powders

Question 56.—*What exactly is a " bulk " powder?*

Answer.—The term " bulk " was applied to shotgun powders when black powder was replaced by smokeless powders. The standard charge for a 12-bore 2½-inch case was 3 drachms of black powder, but for convenience in loading, hoppers (or cylindrical measures) were invariably used, each of which contained a volume of powder which weighed exactly 3 drachms. Smokeless powders were found to be much lighter in density than black powder, yet for purposes of general convenience in loading they were so standardised in manufacture that the same measure could be used for them as for black powder. In other words, the charge of smokeless powder was the same as that of black powder when measured by *volume*, or *bulk*, but not when measured by weight. The term " bulk " then became applied to all smokeless powders which could be loaded correctly with a black powder measure, and it has been in general use ever since.

Bulk powders are convenient because they can be loaded by means of the same hoppers which have been in regular use for at least three-quarters of a century, but they are gradually being discarded in most countries because they must have their densities artificially regulated in order to ensure that an adequate weight of " live " powder occupies the old " bulk " measure. This artificial regulation of density adds considerably to the cost of manufacture and also means that the powder contains a proportion of " dead " substance which tends to increase the recoil, as well as the amount of fouling, without any benefit to velocity.

Classification of Shotgun Powders

Question 57.—*What is meant by the expressions " 33-grain " and " 42-grain " powders?*

Answer.—A 33-grain powder is a powder of which the amount required to fill a 3-drachm black powder measure weighs exactly 33 grains, and a 42-grain powder one of which the same amount weighs 42 grains.

Fibrous Shotgun Powders

Question 58.—*What is meant by a Fibrous Powder?*

Answer.—A powder is called fibrous when it is made from nitro-cellulose and has a fibrous appearance when examined under a pocket lens, rather like minute balls of cotton wool which have been tightly rolled up.

Actually fibrous powders are made by rolling a mixture containing finely divided nitro-cellulose up into grains. In order to prevent these roundish grains from breaking up on handling they are "hardened"; that is they are treated with solvents which make the nitro-cellulose fibres cohere, more or less, without destroying the fibrous appearance. The fibrous hardened grains can be broken down by rubbing in the palm of the hand.

Functionally a fibrous powder is easily penetrated by the hot powder gases which are evolved during burning, and so the grains are easily burnt up, because the thickness of actual powder to be consumed is of the order of the diameter of a single nitro-cellulose fibre.

Gelatinised Shotgun Powders

Question 59.—*What is meant by a Gelatinised Powder?*

Answer.—A gelatinised powder is one which has been made by forming grains from a dough. The dough is made by treating a nitro-cellulose mixture with solvents in a mixing machine. This resulting dough-like mixture is submitted to pressure in presses, or rolling machines, and the grains are formed from the cords, tubes and sheets thus produced. In this way solid grains are formed which are not easily penetrated by the hot powder gases evolved during the combustion of the powder, so the grains only burn on the surface. Consequently these grains must be very thin in order to burn up completely in a shotgun. Powders of this kind are called Solid Grain Powders.

In order to avoid the necessity for making very thin grains for shotgun powders some gelatinised powders are made porous by mixing up minute particles with the nitrocellulose dough. These particles are subsequently dissolved out again and so the grains are left with holes, or pores, in their surfaces. Such powders are called porous gelatinised powders. The degree of porosity can be controlled by the size of the particles which are first mixed in and subsequently dissolved out.

A gelatinised powder has no fibrous appearance when examined under a pocket lens, and even in a porous powder the pores are not always readily seen because they are frequently so small although they are large enough to permit the entry of the hot powder gases under the pressure which is generated in a shotgun barrel, and so the grains are readily consumed.

" Progressive " Powders

Question 60.—*What is meant by a " Progressive " Powder ?*

Answer.—A " progressive " powder is one which develops gases more rapidly as burning proceeds, when this burning takes place at a constant gas pressure. These powders are of two classes, namely : (1) Gelatinised powders consisting of multiperforated grains, in which the burning surfaces increase as combustion proceeds. These powders are used in ordnance. (2) Powders consisting of grains made up of layers which vary in rate of combustion, the outer layer being slow in combustion and the inner layers or core quick in combustion. These powders are used in small-arms.

The word "progressive," as applied to class (2), was coined by Nobel in his patent of 1896, when he said: "The progressive quality is obtained by introducing chemical substances in the outer layers of the compound capable of modifying its explosive character."

The idea is that the projectile should be started in its movement by the slow explosive on the surface of the grains, *and the initial pressures are thus kept low; further* movement is continued by the more violent explosive of the core of the grains, and a more sustained barrel pressure is thus created.

For small-arms powders the progressive character is given by coating the grains with moderating substances which are allowed to penetrate to varying degrees below the surface of the grains; the grains are surface moderated. Because a progressive powder is one which gives comparatively low initial pressures and sustained barrel pressures, powders which have these characteristics are said to be progressive even when the grains are not surface moderated.

Progressive Shotgun Powders

Question 61.—*Which shotgun powders, if any, burn progressively?*

Answer.—It depends on what is meant by "burning progressively." In comparison with shotgun powders used before 1914 all powders made at the present time are more or less progressive in that they develop better sustained barrel pressures, and since 1945 the improvement in this direction has been even more marked.

But if the expression "burning progressively" refers to powders in which the outer layers of the grains are less explosive than the cores, it is safe to state that no shotgun powders now made are of this type.

To obtain this type of progressive action by coating the surfaces of the grains or by some similar method of surface moderation, the powder must be a gelatinised type with solid grains.

The combustion of fibrous powders, or of those with porous gelatinised grains which are surface moderated, does not begin by the burning of the outer layers because the hot powder gases can penetrate the grains and cause them to burn just as readily and as quickly at the cores as at the surfaces. Consequently it is clear that surface moderating cannot give a more progressive burning in the case of a fibrous or porous grain powder by starting with a slow rate of burning of the outer layer and finishing with a quicker rate at the core.

The size of the pores is a useful factor in helping to regulate the rate of combustion.

Recoil given by Different Powders

Question 62.—*Why do some powders give a heavier recoil than others when the same weight of shot is used?*

Answer.—Recoil is dependent primarily, if not solely, on two things: (1) the total combined weights of all the ejecta (that is, the combined weights of the shot charge wadding and powder gases), and (2) the velocity with which these ejecta leave the muzzle. The weights of charges of different varieties of powder are not always the same, and some powders are lighter than others, bulk for bulk. On the assumption that the whole of the powder charge turns into gas on combustion—as it should—it will be obvious that the weights of gas evolved by different powders depend on the weights of the charges of those different powders. Consequently the weight of gas evolved by a powder with a high specific gravity will be greater than that of the gas evolved by a powder of lower specific gravity, and so the total weight of the ejecta when the first powder is used will be heavier than that of the ejecta when the second powder is used The muzzle velocities are so similar when standard loads are adopted that they can be regarded as identical for all practical purposes and so the first powder will produce a heavier recoil than the second.

It is also possible that the rate at which the velocity of the shot charge is developed during its passage up the bore may have an influence on the recoil. But although this is certainly and definitely true in theory, in actual practice the speed at which the velocity is developed can have such slight scope for variation in a shotgun barrel that this factor can be ignored, and it is not likely that any shotgun powders will give appreciably different results in this respect.

" Quickness " of Different Shotgun Powders

Question 63.—*Certain powders are advertised as being " quicker on the bird " than others. Is there anything in this claim ?*

Answer.—No. The " quickness on the bird " developed by any cartridge is really entirely dependent on the time of flight of the shot charge from the muzzle to the bird, and this in its turn depends on the muzzle velocity of the shot charge and the capacity possessed by the shot pellets for retaining that velocity, or in other words, the *average* velocity over the range. In actual practice all cartridges are so loaded that the average velocity over the range is the same, irrespective of what powder is used. It is true that this average velocity may be increased very slightly by imparting an extra high muzzle velocity. But this can only be done by a combination of a light shot charge and a heavier powder charge: the type of powder used is immaterial.

Caps and Powders

Question 64.—*Recently I bought some 12-bore shotgun cartridges loaded with a well-known brand of British powder. The results were most disappointing and the cartridges were obviously very weak as the reports were feeble, I felt hardly any recoil and I noticed a lot of smoke when I unloaded. I found that the cases were of foreign origin. Could this have anything to do with the poor results?*

Answer.—Most definitely, yes. But the cause would not be the cases so much as the caps in the cases, and there can be little doubt that the trouble you experienced was the result of using caps which had not been properly matched to the powder. The caps in themselves may have been quite satisfactory, but this does not necessarily mean that they suited the powder with which they were used.

If the optimum result is to be obtained from any type or make of powder it is essential that it should be used with a cap which has been correctly matched for use with it. When caps used in cartridges are detonated by the fall of the striker they produce a flame which impinges on and so ignites the powder. A great deal depends on the temperature of this cap flame and the force with which it impinges on the powder, and some caps can be too violent and others too weak.

It is impossible to take too much care in matching caps to powders suitably and it is usually a mistake to use caps of different origin from the powder as there is the risk that the two may not match to the best advantage.

Large Continental Caps

Question 65.—*Do the large-sized caps used in some makes of Continental shotgun cartridges effect any improvement in ballistics when used in conjunction with British powders?*

Answer.—One very common Continental cap is actually slightly smaller than the standard British cap although it looks larger owing to its outer covering, but there are two kinds of Continental caps which really are larger. In one of these the anvil is made in the cap chamber by raising its base, and in the other a legged anvil is used, the leg of which protrudes through the flash hole. These methods of manufacture necessitate the use of a large cap and cap chamber, and so the manufacturers are compelled to use a large charge of cap composition. This necessitates a comparatively weak and low temperature flame composition being used, so as not to disturb the pressure level of cartridges loaded with ordinary powders. As is often the case, when manufacturers are compelled to deviate from general practice, merit is made of necessity. Tests have proved that these large caps have produced no improvement in ballistics, while the opposite effect has frequently been recorded. The reason for this is that although the amount of cap composition may be larger the flame produced by this composition is weaker and of a lower temperature than that given by British caps.

Importance of Good Wadding

Question 66.—*One reason given for the considerable difference in price between two brands of ordinary shotgun cartridges was the difference in quality of the felt wadding used in the two brands. Is this explanation correct; and if so, does the better quality felt make sufficient practical difference in the actual shooting field to be worth the extra cost?*

Answer.—Felt varies greatly in quality and price, the inferior qualities being considerably cheaper. Consequently it is quite correct to state that different qualities of felt wads make one of the contributory causes to the difference in price between brands of cartridges.

The felt wad is one of the most important components of a shotgun cartridge, and its function is to expand under the impact of the explosion and seal completely the bore behind the shot charge, thus preventing any of the powder gases escaping through the shot charge. Not only does the felt wad play an important part in the actual development of the ballistics of the cartridge, but it also has a considerable effect on the pattern of the shot charge. Generally speaking, the better the quality of felt wad used the better the pattern. It is, consequently, well worth while to get cartridges loaded with good quality felt wads.

Cork Wads

Question 67.—*Is it true that cork wads help to reduce the recoil ?*

Answer.—Cork wads, that is, wads made of " natural " cork as opposed to " manufactured " cork consisting of small particles of natural cork cemented together, invariably tend to lower the ballistics, and consequently a somewhat heavier powder charge (usually 2 grains) is needed than that used with felt wads. It is true that cork wads tend to reduce the recoil, but the actual reduction due to the cork wad is but 1 to 2 per cent. When the recoil is reduced by a greater amount such reduction is invariably the result of a lowering of the velocity by the use of cork wads. It is, of course, assumed that the weight of the shot charge remains constant.

Air-Cushion Wads

Question 68.—*Are the cardboard "Air-Cushion" wads, which were introduced as a war-time substitute for felt wad, quite safe and satisfactory in practice?*

Answer.—Air-Cushion wads were most definitely not introduced as a "war-time substitute," but were actually introduced, after a long period of trials, in 1936, since when they have been gradually supplanting felt wads to a steadily increasing degree in British cartridges.

These are absolutely safe to use and extremely regular in action provided two elementary precautions are adopted. In the first place they tend to increase the pressure, probably because of the very effective manner in which they seal the bore, and so a slightly reduced powder charge is necessary, the amount of reduction varying with the type of powder used. Alternatively the normal powder charge can be used and the shot charge reduced from $1\frac{1}{16}$ oz. to 1 oz. in the ordinary $2\frac{1}{2}$-inch 12-bore cartridge.

Secondly, a thicker card wad must be used between the powder and the Air-Cushion wad than is usually adopted with felt wads. This over-powder card wad should be $\frac{1}{8}$ inch in thickness instead of the usual $\frac{1}{12}$ or $\frac{1}{11}$ inch.

Gunmakers are now fully alive to these facts and invariably adopt these two precautions when loading with Air-Cushion wads.

Constant Volume Loading

Question 69.—*What is meant by "Constant Volume Loading," and is this system of loading an advantage?*

Answer.—Constant volume loading is adopted by some Continental manufacturers of shotgun cartridges. The powder chamber of the cartridge case is fitted with a lining, the diameter of which is slightly smaller than the diameter of the rest of the case. The effect of this is that a step is made at the top of the powder chamber. A card wad is placed on this step which cannot be pressed further down on the powder, with the result that the volume given to the powder space is always constant, and compression of the powder is impossible. In theory this system is excellent, but in actual practice it has not proved very satisfactory. The reason is that any variation in the weight of the powder charge has effects on the ballistics in two ways: First, on account of the actual variations of the density of loading owing to the reduced air space left in the powder chamber; and secondly, the variation produced by the different weight of powder. The existence of this double source of variation in ballistics has been found to result in greater variations than are produced by the original system of loading, in which the wads are rammed on top of the powder. On the whole, constant volume loading has not been found suitable for British powders, and is not recommended. There is even a danger in constant volume loading as adopted in some instances. The supporting lining in the case may be very thin, and then there is the risk of the wadding being forced within it, thus reducing the air space and materially increasing the pressure.

Gastight Cases

Question 70.—*Is there any real advantage in having an iron lining to shotgun cartridges, such as is used in "gas-tight" cases?*

Answer.—An iron lining produces a stronger case, and consequently results in slightly higher and more regular ballistics. If cartridges are to be kept a long time, "gas-tight" cases are preferable, but for ordinary work they cannot be regarded as adding very materially to the efficiency of the cartridge.

Wet Cartridges

Question 71.—*What is the best method of drying out shotgun cartridges which have got rather wet? Is it safe to dry them fairly near a fire, or on the comparatively cool part of the top of a stove, or in a hot cupboard?*

Answer.—If any cartridges have got so wet that the front ends of the cases have swelled and the turnover become partly loosened the best thing is to scrap them But with modern cases the cartridges would have had to be *very* wet for a considerable time before they need be written off as a total loss.

It can be most dangerous to dry cartridges near any stove or subject them to abnormal heat. Practically all shotgun powders contain a small percentage of moisture and their effectiveness is largely dependent on this percentage of moisture content remaining constant. If cartridges are dried on or near a stove, or "cooked" in any way, the moisture content of the powder is reduced, when combustion becomes much more violent. There have quite certainly been many accidents due to this cause.

The only safe method to adopt is to dry the cartridges out very gradually without submitting them to any excessive heat, certainly not over 70 degrees Fahrenheit if possible. If the cartridges have been more than a little damp it would be safer to let them dry off in a warm living-room for several months, at the end of which time they will probably be quite satisfactory again as the moisture content of the powder will have had a chance to settle down to normal. If this process of drying out the excess moisture is hurried unduly there is the risk of reducing it too much, when the risk of dangerous pressures is very real.

Shotgun Cartridges and Weather

Question 72.—*Are shotgun cartridges affected by the weather?*

Answer.—This depends both on the weather and the quality of the cases used.

Whatever cases are used day-to-day changes of weather can be ignored. As was explained in the Answer to Question 71 the combustion of a shotgun powder depends on the moisture content. If this last is normal the combustion will be normal and the behaviour of the cartridges satisfactory. But if the moisture content is either reduced or increased the cartridges will become either too "strong" or too "weak." Under normal conditions the variation of the moisture content is never a sudden change and cartridges will never be very violent one day and very feeble the next. The moisture in the powder, which is a very small percentage, is only reduced or increased gradually by fairly long spells of hot and dry or exceptionally damp weather. This is but natural and the process will need at least ten days or more at the very least either way.

It is a common experience for sportsmen to find their cartridges abnormally potent and developing an excessive recoil early in the shooting season towards the end of an exceptionally hot summer. This is merely the result of the moisture in the powder being reduced by the long period of exceptional warmth, and if the cartridges are kept until November the powder will have reabsorbed the normal amount of moisture from the air and the results will be normal.

From this it will follow that the capacity of the case to withstand any moisture passing through it will help to maintain the powder in its proper condition, and the more waterproof a case is the better is the chance of the cartridges maintaining their regular behaviour irrespective of the weather.

Storage of Cartridges

Question 73.—*Is there any truth in the theory that cartridges deteriorate when kept from one season to the next, even if carefully stored, and what are the best conditions under which they should be kept?*

Answer.—Under favourable conditions shotgun cartridges will keep in good condition for years. Shotgun powders are chemically very stable under all sorts of climatic conditions on account of their porous nature and the ease with which the gaseous products of decomposition escape from the powder grains. The variation in the ballistics of shotgun cartridges under extreme climatic conditions depends on (1) the temporary effect produced on the powder, i.e., the moisture contents and variation in rate of combustion due to temperature; and (2) the effects, both temporary and permanent, produced on the paper case. A case drier than normal is smaller in diameter than normal and the turnover offers more resistance, which increases ballistics. When a paper case is allowed to become alternately damp and dry, the shot charge gets loose owing to the turnover unrolling slightly, and this lowers the ballistics. It will accordingly be realised that if there were no variations in temperature or humidity of the atmosphere the ballistics of cartridges would remain constant for an indefinite period. Such conditions are, however, impossible to realise, but they represent an ideal which indicates the best practical conditions for storing cartridges. A library is usually a very good place as conditions favourable to the preservation of papers and books are the best possible for cartridges. Extremes of dampness or dryness, or heat or cold, should be avoided as much as possible and when this is done there is no reason why cartridges should not keep perfectly for many seasons.

Shotgun Cartridges in Extreme Cold

Question 74.—*When shooting during cold winters in East Prussia before 1939 there were frequently 15 to 18 degrees of frost Centigrade and under these conditions we found it almost impossible to shoot on account of the failure of the cartridges to " explode " properly. I used German Rottweil and American Ballistite, and both gave equally poor results when the temperature was more than 8 degrees below zero Centigrade. The Germans, when forced to shoot under such conditions, used to keep their cartridges in a pocket close to the body until the last minute before expecting to use them. For duck shooting from open ditches this is, of course, useless as one never knows when a shot may be expected. My experience was the same as that of the local sportsmen. Once when out shooting with a German party I saw one of the guns fire at a hare at about 35 yards. Instead of the normal clean discharge a sort of discoloured mist shot out from the muzzle and travelled along the ground for about 15 yards. Of course the hare was uninjured. The cartridges he was using were of the best standard variety. I came to the conclusion that the powder could not have exploded completely and in this case the cartridges had been carried in the gun for about two hours and had become thoroughly cold. Is there any remedy for this difficulty when shooting in the extreme cold?*

Answer.—The difficulties experienced in very cold weather are accentuated by the oil in the locks getting semi-frozen and this clogs the locks and prevents the hammers from falling with their full force, thus reducing the strength of the striker blow. Further, the metal of the walls of the chamber and the face of the action, as well as that of the cap chamber and anvil, are all intensely cold. This tends to reduce the temperature of the cap flame.

If non-porous or only slightly porous gelatinised powders are used the enfeebled cap flame fails to ignite them properly and the incident noted is clearly a case of a "fizzle" due to incomplete combustion of the powder caused by faulty ignition.

The best remedy is to use a powder which is more easily ignited than either the German Rottweil (which was a rather large grain and only slightly porous gelatinised powder) or the pre-1939 American Ballistite (which was a non-porous gelatinised powder).

Fibrous powders or smaller grained gelatinised powders which are markedly porous would be the best types to use.

The Best Shotgun Powder for Hot Climates

Question 75.—*What is the best shotgun powder for use in a hot climate such as Southern India? Schultze used to be recommended but it is now no longer made.*

Answer.—Schultze was a fibrous nitro-cellulose powder which contained a somewhat exceptional amount of metallic nitrates and it seems probable that the smaller proportion of nitro-cellulose in any single powder charge tended to reduce the effect of the hot temperatures in which cartridges are frequently used in the tropics.

But considerable advances have been made in powder manufacture in recent years and now there is really little to choose between any modern British or American shotgun powder from the point of view of suitability for use in the tropics.

"Not for Ball"

Question 76.—*I have recently inherited an old hammerless 12-bore shotgun by a first-class maker. It appears to be in excellent condition but I see that the flats of the barrels are marked with the words "Not for Ball." Has this fact any* *particular significance? I may say that this is a shotgun and I have no intention of using it for ball.*

Answer.—Since the Proof Marks on your gun, for that is what the marks on the flats of the barrels are, include the words "NOT FOR BALL" they show that your gun was built between October 1875 and December 1887. As it is a hammerless gun its date is probably nearer the later of the two dates given.

It would appear that this gun has never been Nitro Proved and you should most certainly send it to the original maker if he is still in existence, or else to your own gunmaker, and ask one or the other to send it to be Nitro Proved. If the gun passes this test satisfactorily, and if it is a high-grade gun in good condition there is no reason why it should not, you will be able to use it with modern cartridges with confidence.

Before the invention of choke it was a usual practice for sportsmen to use spherical ball in their shotguns for close-quarter shots at big game. But when choke barrels were introduced the constrictions at the muzzle prevented the use of balls of the true gauge of the rest of the barrels; and so, in order to protect sportsmen, the Proof Authorities brought out new Rules of Proof in 1875 emphasising the fact that choke barrels were unsafe for firing spherical ball of the true gauge of the gun, and all guns with any choke were marked on the choked barrels "NOT FOR BALL." The degree of choke was also indicated on each barrel by marking the barrel with the gauges of the breech and muzzle ends as 12B and 14M, indicating that the barrel was 12 gauge at the breech but only 14 gauge at the muzzle owing to the choke.

In course of time, however, many sportsmen used to have the choke eased out a bit and so the original marks indicating the degree of choke no longer applied.

To overcome this difficulty the Proof Authorities brought out fresh Rules of Proof in December 1887 in which a choke barrel was just marked with the word "CHOKE" without any indication of the degree of choke, and the words "NOT FOR BALL" were not used any more as by that time sportsmen fully appreciated the risk of using spherical ball in a choke barrel unless the ball was of a gauge small enough to pass through the choke easily.

You will realise, therefore, that the words "NOT FOR BALL" on a gun fix its date definitely within comparatively narrow limits.

Nitro-Proof Charge for Shotguns

Question 77.—*What is the current nitro-proof charge for an ordinary 12-bore shotgun, and what is the pressure developed?*

Answer.—The current nitro-proof charge for a 2½-inch 12-bore was introduced in 1925 and is now called the definitive proof charge. It is compulsory for all guns, and consists of 178 grains of T.S.P. and $1\frac{1}{16}$ oz. of shot. With the table of pressures now in use it is probable that this definite proof charge develops a pressure of about five tons. The British Proof Authorities do not publish proof pressures, and the special proof powder, T.S.P., is a private powder and is not, therefore, available for testing.

Safety Provided by Proof

Question 78.—*Is Nitro Proof an absolute safeguard? In other words if a gun has been Nitro Proved can it only be burst by a cartridge which develops a higher pressure than that given by the Nitro Proof?*

Answer.—Most definitely, No. All that Nitro Proof, or indeed any Firearms Proof, can do is to submit the steel of the barrels and action to a stress which is considerably higher than any stress which could result from any ordinary cartridge suitable for the gun. This is all that Proof can do and it is really a guarantee that a gun has withstood successfully in every way a stress considerably greater than it should ever be expected to encounter in ordinary service.

But steel varies considerably both in quality and physical condition. For example, if the breech end of a pair of barrels has been appreciably over-heated during the process of brazing the barrels together, it is quite possible that the normal physical structure of the steel has been changed and the metal has been rendered more brittle.

It is also possible for a flaw to exist in the wall of a barrel which would reduce the effective thickness of the wall in that particular part.

In either case it is possible for the gun to be able to withstand successfully the stress imposed by the Proof of both barrels but not to be able to stand up indefinitely to *the constant repetition of the normal stress of use*, when the barrels will eventually fail and the gun burst.

Such accidents are, comparatively speaking, extremely rare: but the possibility exists and should be recognised.

Improvements are constantly being made. For example, the introduction of a special hard solder removes the necessity for brazing, and the joining of the barrels can be effected at a much lower temperature, which reduces the risk of over-heating. Similarly various improved methods of detecting flaws in steel have been inaugurated, such as X-rays, Supersonic Waves, Fluorescent and Magnetic Crack Detection. It is certain that at least one of these, or some alternative but similar method, will be incorporated in Proof in time; but it is not easy to obtain a method which is both positive and not too costly.

The Effect of Wind on Shot Pellets

Question 79.—*Does wind have any practical effect on a shot charge? Is it true that when one shoots directly into a strong wind the velocity of the shot pellets is reduced?*

Answer.—For all practical purposes of sport wind has no effect on shot pellets. It is true that a strong wind blowing across the line of fire must give the pellets a slight deflection. But this deflection rarely amounts to as much as 10 per cent of the total forward allowance required on a crossing bird, even in the case of a strong wind. The effect of a contrary wind on the striking velocity is even less. When shooting into the teeth of a strong wind the velocity of No. 6 shot would be the same at 39 yards as it would normally be at 40 yards in still air.

The Effect of Wind on Different Sizes of Shot

Question 80.—*Does wind have any different effect on shot charges of different sized pellets? That is, would a charge of No. 4 be affected less than one of No. 7?*

Answer.—For all practical purposes of sport wind has no effect on shot pellets, no matter what their size. It is true that a strong wind blowing across the line of fire must give the pellets a slight deflection, and that this deflection will be greater in the case of small shot, such as No. 7, than with large, such as No. 4. But in any case the deflection is so slight that it would make no practical difference in shooting.

Penetrative Powers of Large and Small Shot

Question 81.—*Many years ago an old keeper told me, Use small sized shot; it gets through the feathers more* *easily." Is this true? The diameter of a No. 4 pellet, for example, is of course greater than that of a No. 6. Accordingly it has greater resistance (other things being equal) to overcome in penetrating either fur or feather. Does the extra weight of the No. 4 pellet counterbalance that apparent disadvantage?*

Answer.—Given equal striking velocities the power of penetration possessed by large shot is greater than that of small, and the belief that small shot "gets through the feathers more easily" or "cuts like the edge of a razor instead of that of a blunt knife" is quite erroneous. It is true that owing to its larger diameter (and therefore to the larger superficial area which meets with resistance) a pellet of No. 4 has greater resistance to overcome than one of No. 6 when both are travelling at the same speed. But the heavier a shot pellet is the more easily it is able to overcome any resistance to its movements, and the extra weight of a No. 4 pellet more than counterbalances the disadvantage of its larger area.

In more technical parlance, the power of any individual shot pellet to overcome resistance to motion varies *inversely* as the *square* of its diameter, but *directly* as the *cube* of its diameter. Therefore the net result is that the power to overcome resistance actually varies as the diameter of the pellet.

For example, the diameter of a pellet of AAA is almost exactly double that of one of No. 6, so a pellet of AAA will be able to penetrate twice as easy as one of No. 6.

The power of penetration possessed by an individual pellet is really the same as its capacity for overcoming air resistance, and it is general knowledge that large shot retains its velocity (that is, overcomes air resistance) better than small.

Spread of the Shot Charge.—I

Question 82.—*What is the diameter of the spread of the whole shot charge at 40 yards in the case of improved-cylinder, half-choke and full-choke guns? Are these diameters of spread the same for all bores of guns?*

Answer.—The diameters of the spread of the whole shot charge at 40 yards are approximately 50 inches with an improved cylinder, 45 inches with a half choke, and 40 inches with a full choke. These diameters are approximately the same for all bores of guns since all sizes of guns are bored to give some definite pattern in the same sized circle (30 inches) at the same range (40 yards). In actual practice, however, variations are bound to occur and naturally the spread from an 8-bore is somewhat larger than that from a 20-bore. But the difference is not so great as might be imagined, as the larger the bore the denser the pattern, provided the same size of shot is used, because the bigger guns take heavier shot charges and so fire more pellets.

Spread of the Shot Charge.—II

Question 83.—*At what ranges does the standard load from a 12-bore 2½-inch cartridge give a total spread of 30 inches in diameter when fired from improved-cylinder and full-choke barrels?*

Answer.—Twenty-five yards in the case of the improved cylinder and 30 yards in the case of the full choke.

Length of Shot Column at 40 Yards

Question 84.—*What is the length at 40 yards of the column of shot of a standard load of No. 6 when fired from an ordinary gun?*

Answer.—Not counting a very few straggling pellets, the length of the column is about 8 feet at 40 yards. The whole question of the Stringing of Shot was dealt with exhaustively in Volume III of *The Modern Shotgun*, and all the results given there were later confirmed in America by Mr. P. Quayle ,who has taken spark photographs of shot columns at different ranges.

Effect of Swing on the Flight of the Shot Charge

Question 85.—*Many shooters believe that the " swing " one gives to one's gun affects the flight of the shot charge and imparts a corresponding " swing " to the shot, like water out of a hose. Is there any truth in this theory ?*

Answer.—No. When water comes out of a hose, or when a string of shots is fired from a machine gun, the water and bullets continue to leave the nozzle of the hose and the muzzle of the gun while that nozzle and muzzle are constantly changing the direction in which they are pointing. Consequently the water and bullets are distributed over a wider area than would be the case if the hose or machine gun were stationary. But in the case of a shotgun the column of shot is just about 1 inch in length when it leaves the muzzle. The time which elapses between the departures of the head and tail of the shot column from the muzzle is less than one ten-thousandth part of a second, the average time being about 0·00007 of a second. In this small period of time the barrels of the gun would not have changed their direction to any appreciable degree, no matter how vigorously the shooter made his swing, and consequently the " water from a hose " effect could not possibly be produced.

Nor is there any truth in the theory that swing throws the shot forward to any practical extent. It is true that the actual velocity of the shot charge is the resultant of two velocities which act at right angles to one another, namely, the velocity due to the combustion of the powder which is imparted in the direction of the bore, and the velocity imparted by the swing which acts in a direction at right angles to the bore of the gun. The former velocity, however, is so much the greater that the latter has no practical effect whatever.

Best Shot Sizes

Question 86.—*What are the best shot sizes to use in an ordinary $2\frac{1}{2}$-inch 12-bore against geese, duck, teal and snipe?*

Answer.—It is always difficult, and frequently unwise, to recommend any particular shot sizes, as so much must depend on personal beliefs and preferences. And it is axiomatic that the great majority of sportsmen will shoot best with the shot size in which they have the greatest confidence. Assuming no absurd ideas the best shot size is, like the best load and the best size of gun, that size which the shooter likes best.

Always keeping this fact in mind it should be understood that the best that can ever be achieved must be a compromise which combines a sufficiently dense pattern to ensure a reasonable chance of striking a vital spot at long range and an adequate remaining striking energy at extreme range to ensure requisite penetration.

If this principle is adopted it will be found that the best size of shot in an ordinary $2\frac{1}{2}$-inch 12-bore for geese is a size not larger than No. 1 and not smaller than No. 4. In actual practice there is little to choose between the sizes given by these limits.

For duck No. 5 or No. 6 is probably the best; for teal either No. 7 or No. 8; and for snipe No. 8 or No. 9. But since it can be a nuisance to have to carry various different sizes when a mixed bag is expected, while there is the inexplicable fact that a different bird always gets up from that which is expected, No. 6 will do quite well for teal and even snipe. But if the chances of duck, teal and snipe are about the same, No. 7 is probably the best compromise.

Shot Size and Pattern

Question 87.—*Does the size of shot make any appreciable difference to the total spread, or at any rate to the effective pattern?*

Answer.—No. For all practical purposes the size of shot makes no difference to the total effective spread of the shot charge, but naturally the smaller the size of shot the more dense the pattern.

It is also a fact that in the case of very small shot the result of abrasion and deformation during the passage up the bore may cause a larger proportion of deformed pellets than there would be when using fairly large shot, and deformed pellets frequently have a tendency to fly outwards. There is, therefore, just the possibility that the extreme spread of the charge at any given range might be greater when small shot is used than when large. But pellets which are so deformed as to fly outwards to an exceptional degree are unlikely to be very useful from the point of view of penetration, and so such pellets should not be included in the *effective* spread of the charge.

Drop and Chilled Shot

Question 88.—*What exactly is meant by the terms " Drop " and " Chilled " shot? And what is the difference between them?*

Answer.—All shot in ordinary use is " Drop " shot as this term merely signifies the principle of manufacture.

This *principle is to pour molten* lead through a screen perforated with small holes from a considerable height. The molten lead flows through the holes and forms into round drops as it falls through the air, gradually cooling at the same time. The screen is fitted at the top of a tower and the shot is dropped down through the middle of the tower and caught in a tank of water at the bottom.

Many years ago some manufacturers adopted a method of blowing cold air across the bottom of the tower, and consequently they used to call their shot "Chilled." In reality all drop shot is chilled, and the actual chilling process has no effect on the hardness of the pellets, as might be imagined by many statements which have been made at various times.

The actual hardness of shot depends on the percentages of arsenic and antimony added to the lead as unless small amounts of these elements are mixed with the lead the latter will not run regularly and form into satisfactory drops. The actual percentages of these additional elements do not really vary very much in different makes of shot as there is an optimum percentage which gives the best result as far as the actual round drops are concerned. But a higher percentage of antimony does tend to harden the shot, although the difference is not really very great.

Quite apart from helping the lead to "run" and "drop" very soft shot is a disadvantage as the pellets tend to become more deformed during their passage up the bore. Similarly excessively hard shot tends to ricochet off stones and other natural objects, which can be dangerous. Also it is unpleasant to bite on a very hard pellet when eating game. So the truth is that although degrees of hardness may exist in different makes of modern shot these degrees are not sufficiently wide to make any practical difference.

Mould Shot

Question 89.—*What is "Mould" shot?*

Answer.—It is impossible to obtain perfectly round pellets in the larger sizes of shot by dropping, and so these largest sizes are actually cast in moulds, and the shot which is so made is called "Mould" shot. Usually all sizes larger than AA are moulded.

Meaning of Letters used to describe Shot Sizes

Question 90.—*What is the meaning of the letters used to designate the larger sizes of shot, such as L G, M G, S G, etc.?*

Answer.—The origin of letters used is rather wrapped in mystery and probably they came into being more or less accidentally. There is a general belief that L G means "Large Goose," M G "Medium Goose" and S G "Small Goose." If this is correct "*Special* S G" seems to follow reasonably, but after that it is not easy to fit words to the letters. Another tradition is that L G, M G and S G indicated "Large Game," "Medium Game" and "Small Game," but this explanation does not seem quite so plausible as the former.

The notations AAA, AA, A, BBB, BB and the numbers 1 to 12, all of which indicate sizes, have no special significance or hidden meaning.

Plated Shot

Question 91.—*Is plated shot any real advantage? I have heard great claims put forward for the improved results given by copper-plated shot.*

Answer.—The first patent for plating shot pellets with a metal such as tin and zinc was taken out in England by Sydney Pitt in 1878, so the idea cannot be regarded as new.

Originally the purpose was to prevent contamination of the flesh of game by lead, but in more recent times the object has been to try to protect the pellets from becoming deformed and so avoid ineffective pellets. But the amount of plating put on cannot possibly have any practical effect on deformation. For example, the thickness of the "copper plating" put on at least one brand of shot not very many years ago was just about one hundredth part of a thousandth part (0·00001) of an inch. It is inconceivable that a coating of copper, which is itself a soft metal, of this thickness could afford any useful protection to the pellets against deformation in the barrel.

Test for Penetration

Question 92.—*On skinning a rabbit which I had shot I found several pellets lodged just under the skin on the side opposite to that into which the pellets entered. Does not this mean that the cartridges were weak and lacking in penetration? Otherwise the pellets would surely have gone right through the skin.*

Answer.—The skin of all animals is elastic and always gives to any projectile which strikes it from the inside, and so frequently brings that projectile to rest without its penetration of the skin. In big game shooting it is a very usual experience to find a bullet lodged just under the skin on the far side of an animal, but this is no indication whatever that the bullet is in any way lacking in penetration or that a similar bullet fired from the same rifle would be unable to penetrate right through the body of an animal of the same size as that killed.

Similarly in the case of shot pellets the fact that some pellets are found lodged just under the skin on the far side is no indication whatever that the cartridges are lacking in penetration but merely that the skin is elastic. It is quite usual to find pellets just under the skin on the far side in the case of both hares and rabbits, and not infrequently in birds. After all if the pellet or bullet lodges just under the skin on the far side it means that the whole of its energy was used to maximum advantage, while if the pellet or bullet passes right through it means that some of its energy was lost and wasted.

Pressure and Velocity

Question 93.—*In reports of cartridge tests the following statement sometimes occurs : " The velocities were perfectly satisfactory, but the pressures were somewhat on the low side. These cartridges would probably prove quite effective, but we would prefer to see higher pressures." If the velocity is satisfactory, is not the penetration satisfactory ? And if so, what more can be gained by a higher pressure ?*

Answer.—If the velocity of a shot charge, when fired out of a sporting gun, is satisfactory, the penetration will be satisfactory, as the penetration depends on the velocity. The velocity, however, is generated by the pressure, and the pressure is affected by the size of the bore and chamber in which the cartridge is fired. Ballistic tests are always carried out with pressure barrels which are bored to the minimum dimensions permissible, and consequently the cartridge fits very tight in the chamber and the wads fit tight in the barrel, thus helping to compress the powder gases and develop the maximum pressure possible. Sporting guns are never bored to quite such close dimensions so as to avoid risk of jams, and consequently the pressure developed in such guns is never quite so high as it would be in a pressure barrel. Many guns in common use are old, worn and loose in the bore and chamber, and such guns bring about a considerable reduction in pressure.

If, therefore, the pressure is only just sufficient to produce a *satisfactory velocity in a tight pressure barrel*, *no allowance* is left for the reductions which are inevitable when the cartridges are used in old and worn guns, and under such conditions there is every chance of the pressure being so reduced that the velocity generated is no longer satisfactory. Consequently a warning is necessary when making a report on the tests, and in certain cases where the conditions are such as to tend to the production of low pressures (i.e., when cork or feltine wads are used, or abnormally light powder or shot charges), a suggestion is made to the effect that a slight increase in the powder charge might be an advantage.

The Effect of Air Resistance on Different Muzzle Velocities

Question 94.—*In the answer to Question 11 it was stated that when charges of shot are propelled with different velocities this difference becomes negligible at sporting ranges although it may be considerable at the muzzle. Why is this?*

Answer.—When a charge of shot travels through the air it loses velocity all the time during flight on account of the resistance which the air offers. The greater the air resistance the more rapidly is velocity lost. Further, an increase in the velocity of the shot charge results in a very much greater increase in the air resistance, this resistance varying roughly as the square of the velocity. That is to say, if the velocity of the shot charge is doubled, the air resistance becomes four times as much. Consequently a shot charge which is propelled with a high muzzle velocity loses speed much more rapidly than does a similar shot charge which is propelled with a low muzzle velocity, on account of the greatly increased air resistance. This means that the actual difference between the striking velocities of the two similar shot charges gets less and less as the range increases. For example, a difference in velocities in the neighbourhood of 100 f.s. at the muzzle has been reduced to one of between 40 and 50 f.s. at 10 yards and to one of about 10 f.s. at 40 yards.

Effect of Shooter's Weight on Velocity

Question 95.—*Is it true that a gun will shoot harder when fired by a big and heavy man than it does when fired by a small light man, using the same cartridges?*

Answer.—No. The muzzle velocity of the shot charge is in no way effected by the strength, weight or obesity of the shooter; nor the shooter's capacity for taking recoil on the shoulder; nor by any other knack or skill or shape of the shooter. Consequently there is no truth in the suggestion that a gun will shoot "harder" when fired by a big and powerful man who may, perhaps, stand up to the recoil better than a man of average strength or even a small and light man.

Effect of Reduction of Shot Charge on Velocity

Question 96.—*I have frequently seen it stated that a lighter shot charge than the standard, say, one ounce or even less, does not result in any higher velocity being generated. Is this so, and if so, why?*

Answer.—A shot charge of 1 oz., being lighter, does not offer so much resistance to the powder gases as one of $1\frac{1}{16}$ oz. Consequently it is propelled at a lower pressure and the velocity generated is frequently no more than that developed with the heavier charge. If, however, the cartridge is tightly loaded and the turnover is firm, a normal pressure results, in which case the velocity is slightly higher. The degree of " tightness " with which a cartridge is loaded has more effect on the ballistics than is generally realised.

The Extreme Killing Range of an Ordinary 12-Bore

Question 97.—*What is the extreme range at which game can be killed with an ordinary 12-bore shotgun?*

Answer.—The individual pellets of a charge of No. 6 shot possess sufficient velocity up to a range of 70 yards to ensure penetration in the case of the pellet striking the head or neck of an ordinary game bird, but it is obvious that such a small target cannot be hit without great luck when the pattern is as open as it is at 70 yards. The truth is that any kill made at a range of over 50 yards is in the nature of a fluke because the pattern is too open, even when a full choke is used, to give a reasonable chance of a pellet striking a vital spot.

Extreme Range of 12-Bore Shotguns

Question 98.—*What is the extreme range of an ordinary 12-bore shotgun with No. 6 shot when the gun is fired (a) horizontally and (b) at an angle of 45 degrees? Also what is the height attained by the shot when the gun is fired vertically?*

Answer.—In the first place it must be realised that at extreme ranges the shot charge has spread out to a very appreciable degree along the direction of flight and consequently the central portion of the charge only can be considered. In round figures the ranges for No. 6 shot are as follows: When the gun is fired horizontally, 100 yards. When the gun is fired at an elevation of 33 degrees (which gives the maximum range), 220 yards. When the gun is fired vertically the shot will attain a height of 120 yards. An elevation of 45 degrees only gives the maximum range when a projectile is fired in a vacuum.

Remaining Velocity of a Projectile Fired Vertically

Question 99.—*If a projectile were fired absolutely vertically would it not, in theory, return to the point of departure with the same velocity as that with which it started? In practice this is obviously impossible. Why?*

Answer.—*In vacuo*, where there is no air resistance, a projectile fired vertically would return to the point of departure with exactly the same vertical velocity as that of projection. This theoretical condition, however, cannot exist in actual practice on account of the resistance of the air. The resistance offered by the air prevents the projectile going so high as it would in a vacuum; consequently, for this reason alone, the projectile would not attain the same speed when it returned to the point of departure as it would have in a vacuum, because it would not have so far to fall. Further, during its return to the point of departure the velocity which it acquires through gravity is reduced by the air resistance, and consequently this makes a second reason why the velocity of the projectile when returning is less than that with which it started.

Terminal Velocity.—I

Question 100.—*In the answer to Question 99 it was explained quite clearly why it is that a projectile which is fired upwards in a truly vertical direction does not return to the ground with the same velocity with which it started. But to what extent is the velocity of falling reduced? Out shooting,* *for instance, it is a common experience to hear shot falling almost like rain close to and around one after a neighbouring gun has fired at a high bird. Surely the pellets reach a height sufficient for them to fall with a higher velocity than they seem to judging by the sound? Or is the sound of the falling pellets deceptive?*

Answer.—As was stated in Answer to Question 98 pellets of No. 6 shot will attain a height of about 120 yards when fired vertically upwards, but the height attained is not the only factor to be considered. When a shot pellet, or bullet or shell or bomb, or indeed anything else for that matter, is falling from a height the only force which is pulling it downwards is that of gravity, and this force is directly proportional to the weight of the falling body. But the faster any body moves through the air the greater becomes the air resistance, and when any projectile is falling from a height there comes a point when the force of the air resistance becomes equal to the force of gravity. Once this point has been reached the projectile continues to descend with uniform velocity. If the air resistance tends to slow it down a bit further gravity at once takes charge again and pulls it down faster. But directly a certain speed is attained the air resistance becomes sufficiently powerful to act as a brake. Thus it happens that the two forces, one pulling down and the other pushing up, balance each other when a certain speed has been reached and so prevent the projectile from falling any faster. This critical speed is called the "Terminal Velocity."

The existence of terminal velocity will be appreciated when one considers falling rain. This velocity naturally varies with the size of the drops, but can never be anything but very low, which explains why rain falls so gently, although when the drops are big they come down more heavily.

It is exactly the same with pellets of shot, and the terminal velocity of No. 6 shot is only about 30 f.s., which is the reason for its appearance of falling so gently and why it is not dangerous unless one happened to be looking upwards and was struck by a pellet in the eye.

Terminal Velocity.—II

Question 101.—*In the answer to Question 100 the existence of a Terminal Velocity for all falling objects (including bullets) was explained. Is this why rook shooting with a ·22 is safe? Does the Terminal Velocity of a ·22 bullet prevent it from coming down with appreciable danger?*

Answer.—It cannot be stated too emphatically that rook shooting with a ·22 is not necessarily safe and that every care should be taken not to fire in the direction of houses. It must also be remembered that when shooting rooks shots are seldom taken in a truly vertical direction. This will not mean that the falling bullet will not be controlled by its Terminal Velocity, but it most probably will mean that the bullet will descend nose first and not base first as it would were it fired vertically. The nose of the bullet overcomes air resistance better than the flat base and so the Terminal Velocity of a bullet falling nose first will be higher than the Terminal Velocity of the same bullet falling base first, the actual Terminal Velocities being about 220 f.s. and 150 f.s. respectively in the case of a ·22 bullet.

It is impossible to say exactly how dangerous a ·22 bullet would be when falling with a velocity of 220 f.s., but it would almost certainly kill a biggish bird like a goose, quite probably a child and possibly an adult human being. Naturally everything would depend on where the human being was hit.

The danger should never be forgotten.

Causes of Miss-fires

Question 102.—*I have a gun which I have owned for many years and it has always been very satisfactory until last season when I had one or two miss-fires. I attributed these to the cartridges but lately I have had several more miss-fires with some cartridges which I have but recently bought. I have had the gun examined by a local gunsmith who tells me that the locks are rusty and that this is the cause of the miss-fires. Is this a likely explanation?*

Answer.—It is almost certainly the correct one. You do not say when you last had your gun overhauled but it would seem that this has not been done very recently. A weak mainspring will also cause a miss-fire as this will result in a weak striker blow. But if you have only recently begun to experience miss-fires it would certainly seem that the cause of the trouble is recent and it is probable that a weak mainspring would not have shown up quite so suddenly. But if the striker hole, or lock, or both are clogged with rust or dirt miss-fires may begin to develop comparatively quickly. The rusting process would certainly have become much quicker and more severe once it had begun, and by far the best way of preventing any risk of miss-fires is to have your gun overhauled by the makers between seasons, especially if it has got very wet at any time. Even an occasional overhaul is better than none.

Miss-fires can also be caused by incorrectly shaped strikers, or a striker hole not being placed quite accurately. But in such cases they will be noticed very soon.

If miss-fires begin to develop after a long time you should always send the gun to a gunmaker for overhauling.

Rusting under the Rib

Question 103.—*I have been warned by several friends that the barrels of guns can rust under the ribs. Is this so?*

As the ribs are fixed permanently to the barrels I do not see how the barrels can rust underneath them.

Answer.—Much depends on the interpretation of the word "permanently." The ribs are soldered to the barrels and it not infrequently happens that in the course of time and ordinary usage little particles of solder become detached and drop off, leaving tiny holes. Moisture can, and does, get in through these holes and rusting of the barrels can set in, and even become established, all unsuspected. There have, in fact, been a number of cases of barrels bursting owing to the walls being almost eaten through by rust under the ribs.

The best safeguard is to have your gun examined by a competent gunmaker at least every other season, if not every season. If any holes are found the trouble will be taken in time and the cost of the repair will be well worth while. If no holes are discovered the cost of examination will be trifling and the money a sound insurance.

Some gunmakers smear the outer surfaces of the barrels which will be covered by the ribs with some alkaline substance before the ribs are attached. This is a very excellent precaution as steel will not rust in the presence of an alkali.

And at least one firm make a speciality of "Ribless" guns in which the top and bottom ribs are omitted altogether.

Pitting in Shotgun Barrels

Question 104.—*On looking through the barrels of my gun after cleaning it very carefully I can see a number of black spots of varying sizes in both barrels. I have used a stiff wire brush but am quite unable to remove them. What are they likely to be? Will they do any harm? And how can I get rid of them?*

Answer.—There can be little doubt that the "black spots" you see are really "pits" or the beginning of holes in the barrel caused by rust setting in at different places in spots.

Pits, if allowed to remain, can become a source of considerable danger as it is almost impossible to prevent the corrosion, or rusting process, from continuing and in course of time pits can—and do—eventually become holes. Further, they reduce the strength of the barrel locally and there is the risk of small splits occurring in the barrel at the site of pits.

But if the pitting is taken in time it can be cured completely by a gunmaker who will bore the barrel out until the pitting has been removed. The possibility of this remedy, however, must clearly depend on the depth of the pitting as if this is too deep the wall of the barrel would have to be reduced in thickness so much in order to remove the pitting that it could no longer be considered safe.

In any case after re-boring an old barrel, or barrels, to remove pitting or rust the gun should be sent back to the Proof House at which it was originally proved for Re-Proof.

Cleaning a Gun after a Wet Day

Question 105.—*What is the best way of cleaning a gun when it has got thoroughly wet after a long day's shooting in the rain?*

Answer.—The most essential underlying principle to adopt is that all possible moisture must be removed and what cannot be removed must be allowed to dry out thoroughly before the gun is put away in its case, or even a cupboard.

First take the barrels. Wipe them over and then remove all moisture from the grooves on either side of the ribs by running an edge of blotting paper along them until no more wet can be picked up. Next remove the extractor, or extractors in the case of an ejector gun, by taking out the retaining screw (" stop pin ") which will be found in the bottom of the forward lump or in between the lumps. Wipe the extractor all over and leave it in a warm place, such as on a radiator or even in a hot cupbard, to dry. The insides of the barrels can be cleaned in the normal way, and the barrels themselves, after being dried all over as much as possible, should be left in a hot cupboard or some similar place.

The fore-end should be wiped over and then held with the point inwards and jerked down a number of times so as to fling any water which may have got into it out of the two slots in the rear end. It should then be placed point downwards in a warm corner, but being of wood it will not stand the same amount of heat as the barrels or extractors. While it is standing in a vertical position squirt some Young's ·303, or similar oil, into the slots in the rear end.

Wipe the stock over and then, holding it by the " small," jerk it downwards a number of times so as to shake out any water which may have percolated through into the action via the slots in the knuckle. It is surprising to see how much wet can sometimes be shaken out in this way.

Next, if the gun is a side-lock, remove the locks. This is quite easy but it is advisable always to take them off at full cock as otherwise they may be rather difficult to put back. Wipe the locks all over and leave them in a warm place with the barrels and extractors.

If the gun is a box-lock nothing can be done except to dry it all over. Then leave it in a warm place with the fore-end to dry out.

There is no harm in leaving the components of the gun for 24 hours, and if they have been placed in really warm corners they should have dried out by then.

Now oil the gun thoroughly all over, squirting some oil through the slots of the knuckle and again into the slots in the fore-end. Oil the extractors and stop pin before putting them back.

The gun can then be assembled and left in a rack or else put away into its case.

Always make a rule of keeping an oily rag for wiping over any metal parts touched by the hand before putting a gun away in a rack or its case.

If the gun has got *very* wet several times in a season it should be sent up to the makers at the end of the season for stripping and overhaul.

Storing a Gun

Question 106.—*What is the best method of storing a gun which is not going to be used for several months?*

Answer.—The gun should first of all be thoroughly cleaned, and it is a good plan to clean out the barrels with boiling water. After this has been dried out, the barrels should be smeared inside and out with a fairly thick oil or jelly. Vaseline will answer the purpose well, but a better composition can be made by mixing vaseline and B.S.A. Kleenwell oil or any other alkaline oil in equal parts. The vaseline should be melted, the oil added and well stirred, and the mixture then allowed to cool. The action can be treated in the same way, and the gun put away in its case, or else in a gun cabinet or cupboard.

Compression of Action Springs

Question 107.—*Which is the best way of putting aside an ejector gun between shoots so as to release the ejector and main springs from constant strain due to compression?*

Answer.—It is no more necessary to release the main, or tumbler, springs or the ejector springs of a gun than it is to release the springs of a watch. The loss in strength owing to compression is negligible, even after many years.

The main springs can be released by pulling the triggers. If the gun is in pieces it is better to hold the face of the action against a block of wood, or an old book, when snapping off, so as to give the strikers something fairly hard against which to fall. If the gun is assembled, snap caps should be employed.

The ejector springs present a more difficult problem. In the great majority of actions the simplest way of keeping them released is to remove the fore-end while the gun is still in the "open" position immediately after the snap caps have been ejected. The barrels can then be taken from the stock in the ordinary way. If this is done, however, the ejector hammers must be recocked before the gun can be put together again. To do this the fore-end should be attached to the barrels alone, when it will be found that the ejector heads are protruding beyond the breech end of the barrels owing to the fact that they are held in their extreme backward position by the ejector hammers, which are now uncocked. The barrels should now be gripped firmly and the ejector heads pressed down on some wooden surface, such as a table, until a click is heard which denotes the cocking of the ejector hammers. The ejector heads will then lie flush with the breech of the barrels, and if the fore-end is removed, the gun can be put together in the usual way.

Detection of Loose Actions

Question 108.—*In the answer to Question 25 it was stated that an abnormally severe strain on firing might cause the barrels of a gun to come off the face of the action. What exactly does this mean, and how can such a state of affairs be detected?*

Answer.—A pair of barrels are said to have been lifted " off the face of the action " if the breech end of the barrels *no longer fits tightly against the face of the action ; that* is, against the flat vertical part of the action (when the gun is held in a horizontal position).

If the barrels have been lifted badly off the face of the action daylight can be seen between the breech end of the barrels and the action when the gun is closed and held up against the light. The simplest way of testing whether the action is quite tight or not is to hold the closed gun with the barrels uppermost in a horizontal position firmly with the left hand, grasping the barrels and stock in front of the trigger guard, and then to hit the heel of the stock sharply with the fist of the right hand. If the action is at all loose a distinct rattle will be felt in the left hand every time the gun is struck.

Dents in Shotgun Barrels

Question 109.—*On sending my gun to the makers recently they informed me that there were two dents in the right barrel and one in the left which should be taken out. I was quite unable to see any of these dents. Is there any special method for detecting dents ?*

Answer.—Perhaps the easiest way of detecting a dent is to examine the outside of the barrel rather than the inside as is usually done. The barrels should be removed from the stock and held out just below and in prolongation with the eye, and then manipulated until some dark mass —the top edge of a window is excellent for the purpose— casts a shadow-like reflection on the barrels. It will be found that this reflection takes the form of a thin dark line running longitudinally along the uppermost part of the surface of the top barrel. If this line is foreshortened any dent which may happen to lie on it will immediately show as a break. If there is no such break there is no dent on the longitudinal line. The barrels should then be revolved in turn until the dark line has been thrown on every portion of both barrels, when any dent which may exist will be noticed.

Dents in Gun Barrels

Question 110.—*There is a dent on the underside of the right (improved cylinder) barrel of my 12-bore shotgun. It is about 6 inches from the muzzle and a ridge shows when looking down from the breech. It was accidentally caused by the gun falling on the edge of a stone wall or something similar and is quite sharp, while the ridge on the inner surface of the barrel is very slight. Will this affect the shooting of the gun, which is a high-grade one specially built to my order?*

Answer.—Even a slight dent usually affects a gun's shooting by causing irregularity in the pattern, and on this account, if for no other reason, the gun should be returned to the maker without delay to have the dent removed.

If the gun is used much after a dent is made the walls of the barrel will be weakened at the site of the dent because the passage of every charge of shot and wads up the bore and over the dent (which is a raised lump on the inner surface of the bore) must mean wearing away of the metal raised by the dent. In the case of a very bad dent this wearing action due to shooting would ultimately result in a hole, while with even slight dents the metal must be weakened.

As soon as a dent is noticed the gun should be sent to some competent gunsmith (preferably the maker) who can remove the dent by raising the metal from the inside of the bore. The more a gun is used after a dent has been made the more difficult it is for a gunsmith to raise the dent without leaving any trace.

Preservation of Colour of Lock Plates

Question 111.—*I have recently purchased a new best-grade gun. The lock plates are an exceptionally nice blue, and I would like to preserve this colour if possible. Is there any means of doing this?*

Answer.—Any part of the action which has been case-hardened, including the lock plates, will lose its colour gradually with use. The colour can, however, be preserved for many years provided the surfaces are protected by varnish The lock plates of best guns are usually covered with a special varnish when the guns are finished, but this varnish wears off after a season or two of use. The best plan is to send the gun back to the maker at the end of every shooting season in order to have the lock plates and action revarnished. If this is done the original colour will last for many years.

In any case it is advisable to send guns back to the makers at the end of each shooting season for a thorough cleaning and overhaul, as it is always possible that rusting has set in somewhere in the action owing to some severe soaking on a wet day. If taken in time no harm will result.

Blueing of Barrels and Actions

Question 112.—*I have a ·410 gun and would like to blue the barrel and action. How is this done?*

Answer.—The blueing of gun barrels, or any part of the actions, is not an easy process, and it is unlikely that an amateur would be able to obtain good results, while there is a good chance of his spoiling the weapon. Consequently it is always better to place the weapon in the hands of some competent gunsmith.

Briefly, the procedure is as follows: First clean and polish the parts to be blued very thoroughly and make certain that they are free from all grease. Then dip them in the blueing solution, or else wipe them over with the solution. There are a number of different solutions used, but perhaps a mixture of two parts water to one part of ordinary commercial nitric acid is as simple as any. Then wash the solution off and clean the surface well with a wire brush. This procedure should be repeated several times in order to obtain a really good colour. When the part to be blued has received its final coating or dip and the solution has been entirely removed, it should be heated up to a dull blue heat and then dipped in some oil, such as castor oil.

When blueing barrels the breech and muzzle ends should be corked so as to prevent any of the solution getting inside the bore.

You might do better if you could obtain a small quantity of blueing solution from a friendly gunmaker or armourer, and ask him for the best method to adopt with that particular solution.

A more complicated solution is the following:

	grs.
Copper Sulphate	46
29 per cent solution of Ferric Chloride . .	47
Nitric Acid (standard strength) . . .	46
Sulphuric Acid (standard strength) . . .	35
2·5 per cent solution of Spirit of Nitre . .	91
90 per cent Alcohol	91

Add distilled water to make up to 5 fluid ounces.

After applying the solution let the parts rust for 1½ hours, then wash off with boiling water, clean with a wire brush and repeat three or four times and then rub well with oil. For you should realise that blueing is really a form of artificial rusting.

Pull-Throughs in Shotguns

Question 113.—*Is there any objection to the use of a pull-through in the cleaning of a shotgun? It would seem possible that in careless hands a cord-worn barrel may result, and there may be other objections.*

Answer.—There is not nearly the same risk of wearing the muzzle of a shotgun by constant use of a pull-through as there is with a rifle, because in the case of the latter arm the cord nearly fills the bore and it is accordingly comparatively difficult to avoid contact with the inside edge of the muzzle when pulling through. With the larger diametered bore of a shotgun there is not the same risk provided ordinary care is exercised. If the shooter sees that the cord does not touch the edge of the bore when he is pulling through no harm can possibly be done.

A pull-through, however, is not nearly so effective a means for cleaning a barrel as a rod because no backwards and forwards motion can be obtained; and this is essential for the complete removal of obstinate patches of fouling. It is, however, a most useful adjunct to the cleaning rod and it is a good plan always to carry one in the cartridge bag, or better still, pocket of the shooting coat. Not only is it sound policy to clean the gun by means of the pull-through as soon after shooting is finished as possible and before the return home, but one is also useful for the removal of any mud, peat or other obstruction which at times gets into the bore of a gun while out shooting and which might easily cause a burst if not removed.

Wire Brushes for Cleaning Shotguns

Question 114.—*Is the use of a wire brush for cleaning the barrels of a shotgun harmful in any way?*

Answer.—There is always a risk of slight scratching of the surface of the bore if a wire brush is used, but if the brush is made of brass or soft iron wire this risk is not serious. Theoretically, brass is not a very suitable substance for a brush for cleaning firearms because, during use, small particles of the brass will almost inevitably adhere to the bore: this close contact of brass and steel is likely to set up electrolytic action which is conducive to formation of rust. At the same time it must be admitted that brass brushes are constantly used without ill effects.

There can, however, be no doubt that the safest and best method for removing leading, or any other obstinate fouling, is by the use of some mild abrasive paste (B.S.A. "Cunirid," for example) on a rag wrapped round the jag of the cleaning rod so that it fits the bore tightly.

Leading in Shotgun Barrels

Question 115.—*Near the muzzles of a pair of 28-bore barrels there are a number of dull greyish longitudinal streaks inside the bore which resist all ordinary methods of cleaning. They were not noticeable when the gun was new. What are these streaks and how can they be removed?*

Answer.—The streaks are undoubtedly leading. The constriction caused by a heavy choke, and small-bore guns are almost always very heavily choked, imposes additional friction on the shot charge when it passes the choke and lead is scraped off the outside pellets and deposited on the inside of the bore. This is a common type of fouling in all fully choked guns and it is also found frequently on the cones at the heads of the chambers, where a similar constriction occurs. Leading can be removed easily by cleaning with some B.S.A. "Cunirid" paste smeared on a rag. Very severe cases can be treated with mercury. The muzzle of the barrel to be treated should be corked, then a small amount of mercury poured into the bore, when the breech end should be corked. The mercury is then shaken up and down the bore, when it combines with the lead fouling, and this combination can be emptied out when the bore is clean. Such treatment, however, should never be necessary when " Cunirid " paste is used.

Non-Rusting ·22 Cartridges

Question 116.—*Is it really safe not to clean out a ·22 rifle after using " Non-Rusting " ammunition ?*

Answer.—Yes. The priming (or cap) composition acts as a most effective preventative against rust and there is no need to clean out the rifle barrel after firing.

But after a considerable number of shots have been fired the bore may—and probably will—become " leaded up," that is, fouled with lead from the bullets. All rifle barrels tend to collect a small amount of metallic fouling from the bullet as it travels up the bore and is engraved by the rifling, and in course of time this accumulation of metallic fouling may become sufficient to cause inaccuracy. The lead can then be best removed by the use of a mild abrasive such as " Cunirid " as explained in the Answer to Question 115.

After being cleaned out the bore will tend to rust unless protected either by a film of oil or else by firing four or five shots with " Non-Rusting " ammunition, when it can be left until leading again becomes apparent.

Non-Rusting Central-Fire Caps

Question 117.—*In the answer to Question 116 it was stated quite definitely that it is not necessary to clean a ·22 rifle after using Non-Rusting Rim-Fire cartridges. Does* *this also apply to Central-Fire cartridges, both shotgun and rifle, which have Non-Rusting caps? If not, why not?*

Answer.—In spite of the claims that have been made it is certainly not safe to leave an ordinary shotgun or sporting rifle firing cartridges capped with Central-Fire Non-Rusting caps without cleaning after use. The reason is that the cap composition is a very much greater proportion of the total explosive charge in a Rim-Fire cartridge than in a Central-Fire cartridge. In the former the cap composition is about one-third of the total explosive charge contained in the cartridge; in the latter it is only about one-hundredth part of the total explosive charge. And although it is true that the total explosive charge in, say, an ordinary 12-bore shotgun is much greater than that in a ·22 Rim-Fire cartridge and so the actual differences between the weights of explosive in the two caps may not be so very great, there is also the difference in the areas of the bores which are liable to rust. For the same barrel lengths the area of the surface of the bore of the shotgun is almost exactly eleven times as great as that of the rifle, and so any protection afforded by the cap residue must be much more diluted.

Advocates of not cleaning seem to forget that there is such a thing as atmospheric rusting and that the outsides of barrels can, and do, rust as well as the insides if not suitably protected.

It is always unwise not to clean either a rifle or shotgun after use unless the makers of the cartridges capped with Non-Rusting Central-Fire caps will guarantee to replace free of charge any barrel that does rust if left uncleaned. In the absence of such a guarantee it is safer to clean.

Cleaning Firearms with Water

Question 118.—*The Americans are strong advocates of cleaning out both guns and rifles with boiling water. Is this a good plan, and is it necessary?*

Answer.—The advantages of hot water as a cleaning agent for firearms have long been known and are not an American discovery; in fact, the use of hot water goes back to the days of muzzle-loaders. However, Dr. Wilbur Huff, an American, made fairly exhaustive researches in 1920 by which he showed that the primary cause of rusting in barrels was the residue of potassium chloride from the cap composition and that this residue was completely removed by washing a barrel out with water. This was no new discovery, but Dr. Huff deserves every credit for a very thorough investigation.

In the case of shotguns, when modern British powders are used, such as Smokeless Diamond, E.C. or Schultze, the water treatment is not necessary because these powders leave a residue which counteracts, to a large extent, that left by the cap. But when foreign powders are used the water treatment is a wise precaution.

In the case of rifles the water treatment should always be used without fail. The water need not be boiling. Cold water is almost as efficacious, but hot water evaporates and is thus more easily dried from the bore.

Since the introduction of Non-Chlorate or "Non-Rusting" caps it is really not necessary to clean firearms with water.

Removal of Metallic Fouling from Rifles

Question 119.—*What is the best way of removing the metallic fouling from a rifle barrel which is badly "nickelled"?*

Answer.—There are two general methods of removing metallic fouling, chemical and non-chemical. In the chemical method one end of the barrel is corked and the bore is filled with a solution of ammonium persulphate for about 20 minutes. This solution has no effect on steel, but dissolves copper and nickel. Tablets known as K.N.S. can be obtained from any gunmaker and when dissolved in a solution of ammonia provide the proper fluid to use for removing nickel chemically.

One disadvantage of this method, however, is that it makes the bore *too* clean, as it removes the nickel from any pits there may be. The result is that the bore becomes rough and soon nickels again. After K.N.S. it is a good plan to fire three or four rounds and then to scrub the bore well with some mild abrasive. The pits in the bore will then be filled up and the inside of the barrel will be smooth.

The non-chemical method entails the use of some abrasive paste on a rag, which rubs the nickel away. Such pastes can be made from pumice powder or even metal polish such as "Brasso," while special pastes are sold for the purpose, notably "Motti," B.S.A. "Polishing Paste" and B.S.A. "Cunirid." This last is far the best and safest to use, as all the others mentioned (including pumice and "Brasso") wear away the steel as well as the nickel to varying degrees. In the hands of an expert, however, "Motti" or "Polishing Paste" will remove the nickel far more quickly on account of their rapid abrasive action. But the amateur is advised to use "Cunirid" only.

Cleaning of Rifles after Firing "Non-Fouling" Bullets

Question 120.—*One frequently hears emphasis laid on the fact that the bullets used in some particular rifle are jacketed with "Nobeloy" envelopes which prevent metallic fouling.*

When using such bullets, is it necessary to clean out with B.S.A. "Cunirid," or some other abrasive paste, after firing?

Answer.—It is not essential, but it is certainly better to use some abrasive paste. When "Nobeloy" bullets are used all that is necessary in the way of cleaning is to scrub the barrel out well with some "Cunirid" paste smeared on a bristle brush which will remove both powder and cap fouling as well as the almost negligible deposit of metallic fouling. The bore can then be wiped out with an oily rag, so as to remove the dirty remains of the paste, and finally left coated with some suitable oil, as a preservative against rust.

Necessity for Cleaning Rifles with Water

Question 121.—*In the reply to Question 120 it was stated that all that is necessary in the way of cleaning rifles which fire "Nobeloy" bullets is to scrub out the barrel with some "Cunirid" paste smeared on a bristle brush. But in a previous reply to another question it was stated that it is always advisable to wash out the bore with water (either hot or cold) so as to remove the potassium chloride deposited by the cap. Surely the employment of "Nobeloy" bullets cannot affect the cap fouling, and if water is necessary for the removal of this fouling should it not be used when any type of bullet is fired?*

Answer.—In previous replies the use of water has been recommended because it is a certain method of removing the potassium chloride cap fouling, and also because comparatively few sportsmen take the trouble to use an abrasive cleaning paste. If an abrasive paste is used the water treatment is really a superfluous step, although it can never do harm. If no abrasive paste is used the water treatment should never be omitted, unless Non-Chlorate or "Non-Rusting" caps are used, when it is not really necessary.

Meaning of "Jump" and "Flip"

Question 122.—*What exactly is meant by the term "flip" when applied to rifles? Is it the same as "jump"?*

Answer.—The Artilleryman defines jump as the difference between the angle of elevation and the angle of departure. In other words, it is the vertical angle which the axis of the piece describes under the shock of firing during the interval between the ignition of the powder charge and the exit of the projectile from the muzzle. When the muzzle of the piece moves upwards the jump is said to be positive, and when the muzzle moves downwards the jump is negative.

In rifles and shotguns there are really two elements of jump which should be distinguished. These are: (1) The weapon moves as a whole about the point of the stock where the recoil is taken and gives a positive jump; and (2) the barrel bends, or flips, during the same interval of time in which the first-mentioned movement of positive jump is taking place. The second of these two elements is much the more important, as it exercises the controlling factor on the total movement of the weapon during the shock of firing, and consequently in sporting and military small-arm gunnery the term flip is invariably used in place of jump and is regarded as including both elements.

The flip of a barrel consists partly of a bending, just as a fishing-rod bends when the angler strikes, and partly of a vibrating set up in the barrel by the movement of the cartridge case and breech fittings under the sudden application of the powder pressure. The bending of the barrel during recoil is always negative, because the barrel becomes the arc of a circle and the axis near the muzzle has a direction downwards in regard to its original position, just as the point of a fishing-rod assumes a more downward direction when the angler strikes. But the effect of barrel vibration may be either positive or negative according to the time the bullet takes to travel up the bore, and whether the bullet leaves the muzzle at the top or bottom of a vibration. Actually the resultant flip is the sum of these two effects.

Flip varies with every barrel and action, and even with the same barrel and action when they are bedded differently to the stock. It is dependent on the length and thickness of the barrel; the method of support which the barrel receives; the rigidity of the attachment of the barrel to the action, as well as the action itself; and the tightness of the bearing between the action and the stock.

In actual practice the effect of flip is counteracted in the sighting of the weapon.

Measurement of Flip

Question 123.—*Is there any means of measuring the flip of a rifle?*

Answer.—Flip can easily be measured by arranging the sights so that the line of sight is absolutely parallel to the axis of the bore. The rifle should then be shot at 25 yards, when, if there were no flip, the bullets would strike the target the same distance below the point of aim as the axis of the bore is below the line of sight. The difference between this theoretical point of impact on the target and the actual impact gives the flip. If, for example, the axis of the bore is 1½ inches below the line of sight, the bullets would strike 1½ inches below the point of aim if there were no flip. It is found, however, that they strike 5½ inches below the point of aim; and so the effect of the flip is to throw the bullets 4 inches low at 25 yards. Since 1 inch at this range subtends an angle of ¼ minute, the total flip is 16 minutes, and as the effect is to throw the bullets downwards, the flip is negative.

Alteration in a Rifle's Elevation

Question 124.—*I have a ·375 Mannlicher-Schonauer rifle, which until recently shot remarkably accurately. Recently, when on a trip up the Zambesi, something went wrong with the trigger pull and on my return I sent the rifle for repair to a gunmaker, who put the trigger pull quite all right again. But after I got the rifle back I missed three easy shots at buck, and in each case my bullet went over the animal's back, so I tested the rifle on a target and made a 4-inch group at 100 yards, but 10 inches directly above the bull. The ammunition was the same as I had used before and was quite fresh. The sights have not been damaged in any way. The backsight cannot have been raised as it slips in sideways, while it is impossible for the foresight to have been lowered. How is it possible to explain the sudden change in elevation?*

Answer.—When the gunmaker had the rifle for correcting the trigger pull he must have stripped the barrel and action from the stock. When reassembling the rifle it is probable that some slight change in bedding took place, or else the action screws were screwed up with a different degree of tightness. This change in the bedding of the barrel and action to the stock would be quite enough to cause a change in the flip of the rifle which, in its turn, would result in a change of elevation. If you are satisfied that the action screws are perfectly tight, your best remedy is to file down the backsight a little so as to correct the elevation to the present condition of the rifle.

Resting a Rifle on a Hard Support

Question 125.—*Why is one always warned that it is a bad plan to rest the barrel of a rifle on some hard support when shooting?*

Answer.—A hard support such as a bar of iron, a rock, or the branch of a tree, possesses no elasticity, and consequently if the barrel of a rifle rests on some such support when it is fired, the support interferes with the natural flip of the rifle, with the result that the sighting is altered. There is a tendency for the barrel's downward flip to be prevented before the bullet has left the muzzle, and therefore a high shot is almost inevitable for the sighting taken.

It is always better to place some soft material such as a cap, scarf, handkerchief, or glove between the support and the barrel; or else to rest the hand on the support.

Compensation in Rifles

Question 126.—*I understand that variations in the velocity of the ·303 Mark VII cartridge can be counteracted by what is termed "Compensation." That is, the vibrations due to flip are so controlled in the stocking of the rifle that a low velocity round leaves the muzzle at the top of a vibration and so with an angle of elevation greater than the normal, while a high velocity round leaves the muzzle at the bottom of a vibration, which gives it an angle of elevation less than normal. The result is that the variations in the muzzle velocity above and below the normal are counteracted and the bullets hit the same place at the range for which Compensation is determined. A normal velocity bullet would hit this same place anyhow.*

Could not this principle be adopted to make bullets of different weights, e.g., 174 grains and 150 grains, for the ·303, shoot into the same group at, say, 200 yards? The variation in grouping of the two weights of bullet at 100 yards would then be slight.

Answer.—The possibility of automatic compensation by means of the barrel flip is not so new as many seem to believe and the theoretical possibility was suggested in *The*

Book of the Rifle by the Hon. T. F. Fremantle (now Lord Cottesloe), which was published in 1901.

But the idea received scant attention until at least twenty years later when shooting at Bisley proved that the ·303 S.M.L.E. Rifle, which was very inaccurate when firing ammunition giving varying velocities at 200 yards and 300 yards, gave a remarkable degree of accuracy with the same ammunition at 900 yards and even 1,000 yards. The late Major J. H. Hardcastle did much towards establishing the fact that these results were due largely to an accidental automatic compensation which the rifle happened to give.

Since then much attention and thought have been devoted to the problem, but the fact remains that although it is possible to damp the barrel vibrations more or less to some predetermined amount it is not practically possible to ensure automatic compensation for any given range.

So although in theory it may be possible to estimate the barrel length which would deliver both 174-grain and 150-grain bullets on the same Mean Point of Impact at 200 yards, in actual practice every barrel and every action have their own individualities.

Compensation in rifles is a sublime theory, but for anyone to claim ability to be able to make rifles follow this theory of their own accord with different weights of bullet at any given range is, to say the least, more like the expression of a pious hope.

"Mean Point of Impact"

Question 127.—*What exactly is the meaning of the expression "Mean Point of Impact" used in the answer to the preceding question?*

Answer.—The Mean Point of Impact, or M.P.I., is really an artillery expression, and denotes the centre of a group of consecutive shots made at any range when the same aim is taken in each case.

The Effect of Wind on a Bullet's Flight

Question 128.—*To what extent is a bullet in flight affected by the wind? For instance, if the wind was blowing at 15 f.s. from the target to the shooter, would the velocity of the bullet be reduced all along the range to the extent of 15 f.s.? Or, again, with a wind blowing at 15 f.s. at right angles to the line of fire, would the bullet be deflected 15 feet for every second of its flight?*

Answer.—Probably the easiest way of appreciating the effect of a head wind on a bullet's flight is as follows:

The velocity of a bullet is measured with reference to the rifle, or the ground on which the rifle is situated. When a bullet has a velocity of 2,000 f.s. in still air, the air passes over the bullet at a rate of 2,000 f.s. Now, when the air has some general movement of its own, this movement can only alter the 2,000 f.s. with which the air is passing over the bullet. If, for example, a wind blows at 15 f.s. against the bullet's movement, then the air will be passing over the bullet at 2,015 f.s.

It is clear that this additional 15 f.s. cannot rob the bullet of 15 f.s. of velocity because if it did so the bullet would come to rest in still air after having travelled only 2,000 feet, which it does not.

The effect of the wind is a proportional one, and in the example given would help to resist the bullet's movement. But this resistance alters constantly with the bullet's velocity, as this is reduced in the bullet's movement up the range.

In actual practice a bullet would lose about two-thirds of the wind's velocity after a flight of 1,000 yards on account of the effect of wind blowing from the target to the rifle.

That is, a 15 f.s. head wind would result in additional loss of 10 f.s. velocity after 1,000 yards.

In the case of a wind blowing at right angles to the line of fire the bullet would be blown about one-third of the wind's velocity out of its path. That is, a 15 f.s. wind would result in the bullet being deflected about 5 feet for every second of its flight

The figures given here have been calculated from the example of the ·303 Mark VI bullet given in the *Text Book of Small Arms*, 1909, but they can be taken as being approximately correct for most bullets ordinarily used, although they must naturally vary with different bullets and the velocities at which they are projected.

The Comparative " Quickness " of Bolt Actions and Hammer or Hammerless Actions

Question 129.—*Which is the quicker type of rifle action, a bolt action or a hammerless, such as is used with double rifles ? Or, in other words, what is the difference in the time which elapses between the pressing of the trigger and the striking of the cap when a bolt action rifle or a double hammerless rifle is used ?*

Answer.—There is no difference in the time which elapses between the pressure of the trigger and the striking of the cap when a hammer or hammerless action is used ; but both these types of actions are considerably quicker than any ordinary bolt action.

Consequently a perfect trigger release and firm holding is even more essential to good shooting in the case of a bolt action rifle than in a double hammerless rifle.

Bolt actions, however, usually give a decidedly stronger blow than a hammer or hammerless action, but if the blow is strong enough to explode the cap properly no further strength is necessary.

The "Regulating" of Double-Barrelled Rifles

Question 130.—*Is it a fact, or is it not, that the barrels of a double-barrelled rifle are fixed absolutely parallel to one another?*

Answer.—The axes of the barrels of a double-barrelled rifle are never quite parallel, although in some rifles they may be nearly so. The amount of divergence from a true parallel position depends on the cartridge which the rifle fires and the individuality of the weapon, and consequently the exact relative position of the barrels of two double-barrelled rifles are hardly ever the same. This position of the barrels can only be determined by a number of tests at a target in what is often a prolonged series of trial-and-error experiments, and it is this fact which accounts for the exceptional skill required in the building of a double rifle as well as for the high price which must necessarily be charged.

The reason for the necessity of such tests is as follows:

The axes of the two barrels of a double rifle in which the barrels are side by side must clearly lie on either side of the centre of gravity of the weapon. When the right barrel is fired there is consequently a tendency for the muzzle to be swung outwards to the right, and when the left barrel is fired the muzzle is thrown out to the left. If the axes of the bores were truly parallel the obvious result would be that shots from the right barrel would be thrown to the right of the point of aim, while shots from the left barrol would be thrown to the left.

In order to overcome this "shooting apart" of the two barrels the axes of the bores are set slightly converging at the muzzle. The amount of this convergence depends largely on the velocity developed by the cartridge. In the simplest language it can be stated that the faster a bullet travels up the barrel the sooner it leaves the muzzle, and consequently the rifle will not have had time to swing outwards so far as it would have had in the case of a bullet which moves up the bore more slowly. The result is that rifles with high muzzle velocities do not need the same amount of convergence in the axes of their barrels as do rifles with low muzzle velocities; and the axes of the barrels of rifles which take cartridges developing muzzle velocities of round about 3,000 f.s. are almost parallel, while the axes of the barrels of ball and shot guns, which develop the lowest velocities, show the greatest degree of convergence.

But the actual amount by which the two barrels "shoot apart" is governed by other factors besides the velocity imparted to the bullet. These factors include the tightness of the junction of the barrels to the action; the elasticity of the action itself; and the individual whippiness of every barrel. Consequently the degree of convergence at the muzzle necessary for good shooting must vary with every weapon and cannot follow any rule, so that the only method of determining it is by actual shooting and "regulating."

Accuracy of Double-Barrelled Rifles

Question 131.—*Are double-barrelled rifles as accurate as single?*

Answer.—Theoretically the barrels of a double rifle can be so regulated that the trajectories of the bullets from the two barrels are absolutely parallel, in which case the mean points of impact of the two barrels would be the same distance apart as the centres of the muzzles at all ranges. In actual practice, however, such a state of perfection could only be obtained by a lucky accident, just as some single rifles will give much closer groups than others for no known cause. The groups from each barrel of a double rifle are almost always made to cross at some range, and the greater this range the better. For example, if the barrels gave shots which crossed at 50 yards, the shots from each barrel would be four times as far apart at 200 yards as were the centres of the muzzles. But if the shots crossed at 200 yards, they would only be half as far apart as the centres of the muzzles at 100 yards and 300 yards. But however true such statements are theoretically, they cannot be carried out with certainty in practice, except by chance, and a regulator who finds that his rifle will place all its shots from both barrels in 4 inches at 100 yards will probably let well alone, while if he can obtain a 3-inch group he will regard himself as being decidedly fortunate.

In addition to the difficulty of getting the two barrels to shoot together there is also the chance that one of the barrels may not give such good groups as the other, and the accuracy of a rifle depends on its wide groups rather than its close ones. Consequently with a double rifle there is twice the difficulty of getting a close shooting weapon as there is with a single, although it is also probably true that the support which the two barrels mutually supply to each other may help them both to give better groups than they would were they shot separately.

Consequently it will be realised that, apart from a lucky accident, even a good shooting double will never be quite so accurate as a very close shooting single, although a good double will as often as not shoot quite as well as the average single.

In any case a good shooting double will group more closely than most men can hold, especially at sporting ranges up to 300 yards.

Sighting of Rifles at High Altitudes

Question 132.—*I find that my rifle, a sporting ·375 Mannlicher-Schonauer, shoots from 2 feet to 3 feet higher at 150* *yards out in Kenya than it did in England. I attribute this difference in elevation to the rarefied air due to the altitude (5,000 feet to 9,000 feet). Is this correct? In any case, one effect of the rarefied air must be a greatly increased muzzle velocity.*

Answer.—Although a change of elevation of from 2 feet to 3 feet at 150 yards seems rather excessive, it is certainly a fact that most sportsmen have noticed that their rifles do shoot considerably higher on the Highlands of East Africa than they do in England with the same sighting and cartridges. But at sporting ranges up to 300 yards this difference in elevation has little or nothing to do with the rarefied atmosphere due to the altitude. Up to 200 yards no modern rifle would shoot more than from 2 inches to 6 inches higher when fired at 6,000 feet than it does at sea-level; and even at 300 yards the difference would in no case be more than 6 inches. The effect of the rarefied air would become more pronounced at and beyond 500 yards; and at this last-named range the difference might be about 2 feet.

This very general experience of sportsmen in East Africa is almost certainly a result of light. All target shots know how great the effects of variations in light can be, and there is undoubtedly something about the light in East Africa which makes men shoot high.

In the case of rifles firing cordite an additional reason for very high shots is often to be found in the increased ballistics due to the cordite being raised in temperature by the tropical sun. In very hot climates a rifle firing a charge of 75 grains of cordite will shoot a foot high at 100 yards, and so-called "Tropical Charges" are of little help. The remedy is to use a nitro-cellulose powder instead of cordite.

The actual muzzle velocity is, for all practical purposes, unaffected by the reduction in atmospheric pressure due to altitude.

The "Lead" in the Barrel

Question 133.—*What exactly is the "lead" in a rifle barrel?*

Answer.—The "lead" in a rifle barrel is the short, smooth and tapered portion of the bore which connects the head of the chamber to the rifled portion of the bore. Although the correct spelling is "lead" it would greatly simplify matters if the phonetic spelling "leed" were universally adopted.

Stream-line Bullets

Question 134.—*What exactly is a stream-line bullet, and what special advantages does it possess?*

Answer.—A stream-line bullet is a bullet which has a tapered base as well as a tapered head. The longitudinal section of such a bullet is very similar to a horizontal section of ship. The advantages of a stream-line bullet over an ordinary square-based one lie in its greater capacity for overcoming air resistance, which gives it a much flatter trajectory at long ranges; a higher striking velocity at long range; and greatly increased ranging power.

Stream-line Bullets

Question 135.—*Why is it that the tapered base of a stream-line bullet gives it greater capacity for overcoming air resistance?*

Answer.—When a bullet travels through the air there are two distinct kinds of resistance to its motion, namely, a resistance at the head which tries to push it backwards, and a suction at the tail which tries to pull it backwards.

This suction at the base of the bullet is proportional to the diameter of the very end of the tail, and so a small tail means reduced suction. It is not possible in actual practice to utilise this fact to extremes and make the tail a sharp point, as such a bullet will not shoot accurately. The whole art in designing a stream-line bullet consists of making one which will shoot accurately but which has as sharp a tail as possible, so as to reduce the backward pull during flight and thus eliminate as far as possible one of the resistances to the bullet's forward movement.

Stream-line Bullets

Question 136.—*If the addition of a stream-lined base gives to a bullet enhanced powers of overcoming air resistance which result in a flatter trajectory and greater striking velocity at any given range, why are stream-line bullets not used in sporting rifles?*

Answer.—There are two distinct kinds of resistance to a bullet's motion when travelling through the air, as was stated in answer to Question 135, namely, a resistance at the head and a suction at the tail. The former increases very rapidly as the velocity is increased, but once the space of low pressure at the tail (which causes the suction) has become a vacuum, this suction cannot increase any further, because a vacuum is the limit of low density which it is possible to attain.

In actual sport ranges greater than 300 yards need not be considered, and at these very short distances the velocity of a modern bullet is so high that the resistance at the head of the bullet is terrific, while the suction at the tail cannot increase beyond a certain point. So it will be clear that at short ranges the suction at the tail is a very small proportion of the total resistance, and so its reduction by means of a stream-line base will have little effect on this total resistance.

Extreme accuracy, however, is essential. And since it is easier to make a square-based bullet shoot more accurately than a stream-lined one, the very slight advantage which the latter type of bullet would give at short ranges is more than counterbalanced by the certainty of greater regularity in shooting of the former.

At long ranges, however, when the velocity has fallen considerably, the resistance at the head has also fallen, while the suction at the tail remains the same. In these circumstances the suction at the tail constitutes a large proportion of the total resistances to movement, and so its reduction by means of a stream-lined base reduces the total resistance very considerably, with the result that the bullet retains its velocity better and so has a flatter trajectory and a greater striking velocity. In sport these conditions do not prevail owing to the short ranges at which shots are taken.

Ballistics and Accuracy of Different Lengths of Rifle Barrels

Question 137.—*What would be the loss in velocity, energy and accuracy resulting from the reduction in the length of a barrel of a sporting rifle from 28 inches to 23 inches? One would imagine that accuracy would suffer considerably owing to the reduced sight-base and the shorter distance which the bullet would have to travel in the bore.*

Answer.—On the assumption that the rifle in question is a high-velocity sporting weapon, the loss in muzzle velocity would be 3·4 per cent and in muzzle energy 6·8 per cent. The loss in accuracy would, for all practical purposes of sport, be due only to the reduction in sight-base, which depends on the type of rifle and the type of sights used. In the case of a double-barrelled or single-barrelled falling-block weapon which is fitted with a V backsight, the sight-base would be about 20 inches with a 28-inch barrel, and 15 inches with a 23-inch barrel, in which case any error in aim would be increased by 25 per cent when the shorter barrel was used. With a bolt-actioned rifle the sight-base is longer, as the increased length of the action permits of the backsight being placed nearer the breech end of the barrel without being too close to the eye, and the respective sight-bases would be about 24 inches and 19 inches, in which case the shorter barrel would increase any error in aim by slightly less than 23 per cent. (22·7%)

With aperture sights the sight-bases would be longer in every case and the shorter barrels would only bring about a reduction of about 15 per cent with a double or falling-block action rifle and about 14 per cent with a bolt-action magazine weapon.

If a telescope sight were used there would be no loss in accuracy at all.

The First Shot from a Clean Rifle Barrel

Question 138.—*In the reply to Question 32 it was stated that a shot fired from an oily rifle barrel is frequently not found in the middle of the group made when the barrel is slightly fouled. Does this also apply to a shot fired from a clean barrel which has been wiped free of oil? If so, how can one make certain of getting an absolutely true shot for the first shot of the day at a stag unless one fires a "blow-off" round through the rifle before starting out for a day's stalking?*

Answer.—A rifle barrel can be in three conditions: oily; clean and dry; or slightly fouled by a previous round or rounds. A shot fired from an oily barrel cannot be relied upon, but one fired from a clean and dry barrel, which is free from oil, should be in the middle of the group made when the barrel has been fouled slightly by firing. Consequently the first shot of the day should be absolutely true provided the barrel has been wiped free of oil. The best method of removing oil from a barrel and chamber is to wipe out with a rag dipped in petrol, which dissolves the oil. A run through with a dry rag will then ensure the barrel being perfectly dry.

Ricochets of Bullets off Water

Question 139.—*Is there a critical angle for bullets ricocheting off water? If so, what is it? I ask because some of my friends use fairly high-powered rifles with considerable effect for destroying pike in trout streams, but it seems to me that this practice might be distinctly dangerous as a ricochet will carry a long way and may travel in almost any direction.*

Answer.—The possible danger of a ricochet off water is quite real and should always be realised and remembered.

Actually the critical angle for a ·303 Mark VII bullet to ricochet off the surface of water is just above 30 degrees. But it is always advisable to play for safety and never take a shot at a more acute angle with the water than 45 degrees, which is fairly easy to judge. It must not be forgotten that on a windy day the bullet might happen to strike the surface of the water on the far side of a small wave, in which case the actual angle of incidence between the bullet's path and the actual plane of the surface struck would be reduced appreciably. So on a windy day it is better to leave the rifle behind especially as it is then also much more difficult to see any fish in the water and at least one case is on record of a big trout having been shot in mistake for a pike.

The Mauser Action

Question 140.—*Was the Mauser rifle and action originally made in Germany by a man named Mauser, or is there another origin for the name?*

Answer.—The Mauser action was invented by Paul Mauser, the son of a German soldier (probably a craftsman), who worked in the Oberndorf factory and eventually became manager. He made the first Mauser rifle with his brother Wilhelm. In 1863 Paul Mauser was associated with Norris of the Remington firm, and worked at Liége. In 1873 the German Government ordered 100,000 Mauser rifles, which were made at Oberndorf.

The actual patent rights expired a good many years ago, and the principles of the Mauser action have been embodied in many modern bolt actions made by different makers in Europe and America.

Designations of American Rifle Cartridges

Question 141.—*What do the different figures used for the designations of many American rifle cartridges signify? For example, what does ·30—30 mean?*

Answer.—In the early days of central fire breech loaders it frequently happened that a cartridge designed for a certain calibre of rifle was improved, and usually this improvement was effected by lengthening the case so as to take a heavier powder charge.

In order to distinguish the different cartridges they were named both by the calibre of the rifle which they fitted as well as the weight in grains of the black powder charge originally used.

Thus ·30—30 means a cartridge case for a rifle of ·30 calibre which was designed to take 30 grains of black powder. Similarly a ·44—40 is a cartridge for a ·44 calibre rifle designed to take 40 grains of black powder.

The ·32—20 and ·32—40 are both cartridge cases designed for use in a ·32 calibre rifle, but the first will only take a charge of 20 grains of black powder while the second, which is a longer case, takes a charge of 40 grains.

This system is of the greatest help to sportsmen when ordering cartridges for rifles which are made with the same calibre but with different chamber dimensions.

In recent years, however, very high-powered cartridges designed for use with smokeless powders have become increasingly popular and when any of these new cartridges happens to carry a bullet of the same nominal calibre as that used in older types of rifle taking a different cartridge, the new cartridge is distinguished by including both the calibre of the rifle and the muzzle velocity developed. For example, the ·250/3000 means a ·250 rifle cartridge which develops a muzzle velocity of 3,000 f.s., and is obviously a very different thing from the ·25—20 just as a ·22 High Velocity Savage is very different from the ·22 Hornet and even still more different from the ordinary ·22 rim fire cartridge.

And finally it is possible for a particular cartridge to be described by its date of origin as well as its calibre, e.g., the ·30—06 which signifies the ·30 or ·300 military Springfield cartridge which was brought out in 1906.

The second figure used in each designation really makes it quite obvious what is meant.

✓ Take-Down Model Sporting Rifles

Question 142.—*Is a take-down model single-barrelled magazine sporting rifle as reliable and as accurate as an ordinary rifle in which the barrel and action are permanently fixed to the stock? The fixed model is certainly more fool-*

proof, especially when handled by some native gunbearers, but its greater length can be a nuisance when travelling or marching, for I always like to carry my rifles in their cases when on the march.

Answer.—It is doubtful whether any type of take-down model can ever be as permanently certain and reliable as an ordinary "fixed" single-barrelled magazine-actioned rifle. Naturally double rifles are not being considered as they obviously come into a different category.

It is certainly probable that the type of take-down rifle in which the barrel and action always form one unit is more likely to be permanently reliable and constant in sighting than other types. But the fact remains that take-down models by good makers do retain their rigidity to a remarkable degree.

In the type in which the barrel and action remain as one unit there should be no variation in sighting after taking the rifle down and re-assembling it provided the two controlling action screws are always tightened up correctly and the recoil lug at the breech end of the barrel is well bedded against the recoil plate in the body.

As you say, fixed models are more fool-proof although their length can sometimes be a nuisance when travelling. Every sportsman must decide for himself whether it is better to risk the possibility of missing some exceptional head owing to a take-down model not being properly assembled, or to undergo the extra nuisance in travelling caused by the longer case of a fixed model.

Silencers

Question 143.—*Are "Silencers" on rifles and pistols really effective in deadening all the noise of the report?*

Answer.—In theory they can be completely effective with some types of weapon, but in actual practice they seldom are.

A " Silencer " is really a long metal cylinder which fits on to the muzzle of the weapon and which carries inside it a number of baffle plates, the bullet passing out through the holes in the centres of these baffles. In principle it is the same as the silencer on a motor car. The report of discharge is caused by the impact of the sudden efflux of powder gases on the air as they rush out of the muzzle of the barrel with a very high velocity. The baffle plates control this efflux so that the " cloud " of gas is broken up inside the cylinder and the total volume of gas tends rather to " trickle " out of the front end of the cylinder.

The efficiency of the " Silencer " depends entirely on its internal volume being adequate to accommodate all the powder gases, and this volume is surprisingly large. In the case of a ·22 rim fire cartridge the cylinder must be at least 6 inches long and 1¾ inches in diameter. For cartridges with heavier powder charges the cylinder must be still larger if it is to give 100 per cent efficiency.

In actual practice a cylinder of adequate size is so big, clumsy and heavy that a smaller one giving about 80 per cent efficiency is more generally used, which is called a " Sound Moderator."

In the case of revolvers or self-loading pistols it is impossible to obtain 100 per cent efficiency even if the cylinder were fully adequate in size because in all revolvers there is a big escape of powder gases between the front end of the cylinder and the rear end of the barrel, and in self-loading pistols there is an escape of gas at the breech when the fired cartridge case is automatically ejected. It is, however, possible to obtain something between 70 to 80 per cent of efficiency with a self-loading pistol of larger calibre than ·22.

With high-power rifles or any weapon which develops a muzzle velocity greater than the speed of sound there is the additional complication of the " bullet noise " which is additional to the "gas noise" and cannot be controlled by any "Silencer," however big the cylinder, for this is the sharp "crack" which a high-velocity bullet makes when passing through the air.

But with ordinary ·22 rim-fire rifles firing cartridges giving a muzzle velocity of less than 1,100 f.s. an ordinary "Sound Moderator" is most efficient and reduces the noise of the report so much that a rifle fitted with one can become a most useful weapon for shooting rabbits or vermin as well as a most dangerous one in the hands of a poacher.

Drift

Question 144.—*What exactly is "Drift"? Has it any relation to the rotation of the earth? Does it only occur with rifled barrels, and is it always in one direction?*

Answer.—Drift is best defined as the lateral displacement which the bullet suffers during flight from the vertical plane passing through the axis of the bore.

It is due solely to the spin of the bullet and so always acts in the same direction as the twist of the rifling.

In the British service rifle the twist is to the left and so the drift is to the left. In barrels with a right-hand twist the drift is to the right.

At 1,000 yards the drift of the ·303 service bullet is but 10 inches, and at shorter sporting ranges it is negligible, although it can be considerable at extreme ranges which are sometimes used by machine guns.

Advantages of Nitro-Cellulose Powder over Cordite

Question 145.—*What exactly are the advantages of a nitro-cellulose powder over cordite when used in sporting rifle cartridges?*

Answer.—Nitro-cellulose powders have two great advantages over cordite, namely: (1) they are much less severe in wear on the barrel as they do not generate such high-temperature gases as are produced by the explosion of cordite; and (2) they are not nearly so sensitive to changes of temperature. In a hot climate cordite develops considerably higher ballistics than it does in England, and consequently the sighting and grouping powers of a rifle are frequently altered when it is used in the tropics. A nitro-cellulose powder, on the other hand, is not affected to nearly the same extent by extremes of temperature, and consequently the sighting and grouping powers of a rifle are similar to the results obtained in England even when the rifle is used in some very hot country.

Disadvantages of Nitro-Cellulose Powders

Question 146.—*In view of the most important advantages which nitro-cellulose powders possess over cordite for sporting rifles, why are they not universally used?*

Answer.—Nitro-cellulose powders possess disadvantages as well as advantages. For example, they are not so powerful as cordite, bulk for bulk, and in many rifle cartridges—especially those which were designed before 1914—it is impossible to obtain the standard velocities with any nitro-cellulose powder because the cases are too small to permit sufficient powder being loaded to give the bullet the velocity required.

But even when the cases are big enough to allow the standard ballistics to be developed the cartridges will not keep in good condition for very long, especially when stored in a damp tropical climate, unless the caps are of a special type.

Consequently if cartridges loaded with a nitro-cellulose powder are used, it is essential that they should be quite fresh. In the tropics, especially in countries where damp heat is prevalent at some time of the year, no nitro-cellulose cartridges should be used which are known to be more than twelve months old.

" Lethal " and " Contractile " Bullets for Big Game

Question 147.—*Can " Lethal " or " Contracile " bullets be used from an ordinary shotgun with satisfactory results against big game ?*

Answer.—Both Lethal and Contractile bullets can be fired from ordinary shotguns even when the guns are bored with heavy choke, but the accuracy is not so good in a choke barrel as in an improved cylinder, or cylinder, barrel. Up to 50 yards, however, the accuracy should be sufficient for the normal requirements of practical sport.

Both these types of bullets give very effective results on game, but it should be remembered that the powder charges permissible in ordinary game guns cannot be sufficiently heavy to produce very great penetration and shock on large and heavy animals. Consequently these bullets should be used with caution, but for close-quarter work in thick jungle there can be no doubt that they enable a sportsman to use his ordinary game gun with excellent effect. But even so, the same killing power must not be expected as would be given by a heavy cordite rifle, such as a ·470.

Lethal and Contractile bullets are both spherical, but different types of elongated bullets, such as the Brenneke, Rotax and Winchester Rifled Slug, have been introduced in which spin is imparted to the bullet and stability in flight is thus improved. The underlying principle of these bullets is the same, namely, the inclusion of spiral ridges on the cylindrical portions of the bullet which tend to make the bullet spin during its passage through the air. The diameter of the bullet proper is less than that of a full choke and thin circumferential ridges, which can be squeezed through the choke without stress, help to prevent any escape of gas past the bullet while it is in the bore of the gun.

In theory these bullets may be better than the spherical type, but in practice there is probably not much to chose between them at the ranges at which they are likely to be used.

Improvised Shotgun Projectiles

Question 148.—*In 1940, when serving with the Home Guard, some of us were told that we could turn an ordinary shot cartridge into an effective weapon by cutting it through the middle. I have been recommended the same dodge for destroying grey squirrel dreys and a friend of mine advises removing the top wad and pouring in melted wax. Are either of these devices safe?*

Answer.—No. The first plan, namely cutting the cartridge through the middle, is especially dangerous as it must result in shooting a projectile through the barrel which has a greater diameter than the barrel, since the outside diameter of a shotgun cartridge case is greater than the internal diameter of the bore. The inevitable effect is to produce pressures which are highly dangerous. This method should never be tried in any circumstances.

Pouring molten wax into the shot charge is a somewhat safer procedure, but even with this plan there is the most serious risk of bulging the barrel at the choke.

If you want to improvise a projectile for destroying dreys a better plan is to cut a *16-bore* cartridge in half through the felt wad and load the half containing the shot into a 12-bore cartridge instead of the usual shot charge. The pressure developed by such a projectile would be normal, but even then there is a serious risk of bulging the barrel at the choke, for although the diameter of a 16-bore cartridge is less than that of a 12-bore barrel it is by no means always less than the diameter of the choke. So it is absolutely essential to try whether the 16-bore cartridge can be inserted into the 12-bore muzzle before even thinking of using this form of projectile.

Rifling and Bullet Stability

Question 149.—*I have measured the twist of rifling in a number of big-game rifles and find a considerable difference. For instance in the ·404 and larger bores the twist seems to be 1 in 15 to 1 in 17, which is much slower than that used in the smaller bores which seems to be 1 in 10 to 1 in 12, even when these rifles are firing bullets of less sectional density than those of the larger bores. I want to get the maximum bullet stability for close shots with my ·404 and have been told that if I got a barrel made with a twist of 1 in 10 the bullets would strip unless the jackets were made stronger; the pressure would increase; and the velocity fall. Is this so?*

Answer.—Your question is really based on a very popular confusion of thought due wholly to the perfectly absurd system of quoting the twist of rifling as one turn in so many *inches*. This plan originated through the method of setting the cutters on a rifling machine and for that purpose was convenient enough. But it leads to much confusion and the only sensible plan is to adopt that used in all artillery work which refers always to the twist as one turn in so many *calibres*. For this is the only method which conveys an accurate idea of the relative speed of twist irrespective of the bore of the weapon. For example, if we consider ·500 and ·250 rifles and take the twist of one turn in 10 inches for each rifle it will be obvious that the twist of the latter is twice as slow as that of the former. To give the same twist for each rifle the ·500 would need one turn in 20 inches when the ·250 had one turn in 10 inches.

This explains the apparent differences in twist of the different sized bores which you mention.

The optimum twist for any rifle is the slowest which will give accurate shooting at very close ranges ; for provided the twist is sufficiently rapid to give stable flight to the bullet, and consequently accurate shooting, nothing is to be gained by using a quicker twist. In general terms it can be stated that the quicker the twist the more rapidly will the bullet settle down into its trajectory, which means greater accuracy at very close ranges.

It must be remembered that the rotational velocity of a bullet does not fall off nearly so rapidly as its longitudinal velocity, and consequently the greater the range the more rapid is the rotational velocity in comparison with the longitudinal velocity, and so the more pronounced is the tendency of the bullet to maintain stability.

In actual practice if a rifle is tested at some very close range, say 15 yards, and it groups accurately it can be assumed that the twist is sufficiently rapid. Nothing can be gained by using a quicker twist.

An Old Problem.—I

Question 150.—*The Guard in his van at the rear end of a train wishes to shoot the Engine Driver. The train is travelling at 60 m.p.h. and the Guard will be using a revolver which has a velocity also of 60 m.p.h. Will the Guard be able to hit the Engine Driver ?*

Answer.—Of course he will, provided his aim is accurate.

The apparent " catch " in this problem is the fact that the speed of the bullet and the train are ostensibly the same, and so it is thought that the bullet cannot travel along the train in the direction in which the train is moving. But this idea is quite false. The velocity of the bullet is 60 m.p.h. relative to the revolver ; that is the bullet leaves the muzzle of the revolver with a velocity of 60 m.p.h. But since the revolver is in the Guard's hand, and the Guard is in the train and being carried by the train, both the Guard and the revolver are also moving at 60 m.p.h. This speed of the revolver is fixed as long as the train is moving at 60 m.p.h. But the bullet leaves the revolver with a *further* velocity of 60 m.p.h. and so its actual velocity relative to the ground underneath is 120 m.p.h., although relative to the moving train it is only 60 m.p.h.✓In other words the bullet will travel up the train at 60 m.p.h. and so reach the Engine Driver just as the Guard himself can travel up the train to examine the passenger's tickets even if he can only walk at 3 m.p.h. along the corridor. But while doing so he will be moving over the ground under the train at 63 m.p.h.

This question is constantly cropping up in various forms, such as what is the actual velocity of a bullet fired from a rifle which normally gives a muzzle velocity of 2,000 f.s. when the man firing the rifle is travelling in a motor-car at 60 m.p.h. and fires forward straight in front of the car ? In this case the actual velocity of the bullet will be the sum of the normal velocity and the speed of the car, that is 2,088 f.s. If the man shoots backwards from the car the actual velocity of the bullet will be the difference between its normal velocity and the speed of the car, namely, 1,912 f.s.

An Old Problem.—II

Question 151.—*In the answer to Question 150 only shots taken along the train were considered, that is in exactly the same direction of movement as the train. But what is the effect of firing at right angles to the direction of movement ? For example, suppose a train were travelling at 60 m.p.h. and one wanted to hit a particular stationary target on the* *ground to the side of the train. What should be the effect of the train's movement on one's aim.*

Answer.—These problems only appear to be puzzling because the shooter is being carried along in a train, or some other vehicle, and so is moving over the ground. The effect of passing any fixed object in a train at 60 m.p.h. is really exactly the same as if the shooter were standing still on the ground and the object was passing him at 60 m.p.h. *but in the opposite direction.* The shot should be taken exactly as if this was what was happening. That is if the shooter is standing square to the track and looking out of the right side of the train he should shoot just as if he were standing on still ground and the object was passing him *from left to right* at 60 m.p.h.

A similar problem arises when two vehicles are travelling side by side at, say, 30 m.p.h. If a man in one wanted to shoot a man in the other he should fire exactly as if both were standing still and make no allowance for movement of the target at all. This will, perhaps, be understood better if the example is taken of two men on the deck of a steamer moving at 30 m.p.h. past a pier head. Relative to each other the two men are stationary and offer " sitting " targets even though both may be passing the pier head at 30 m.p.h.

The principle is the same in all such problems and is best understood if the only thing considered is the movement of the shooter and the target *relative to each other* and movement of either or both *relative to the ground* is ignored.

Ballistic Coefficient

Question 152.—*What is the " Ballistic Coefficient " of a bullet?*

Answer.—The Ballistic Coefficient of any projectile is a figure indicating the capacity possessed by that projectile for overcoming the resistance of the air and so retaining its original velocity. Other things being equal, a projectile with a good Ballistic Coefficient overcomes air resistance better than a projectile with a poor one, and consequently the striking velocity of the former is higher at long ranges than that of the latter, even though the muzzle velocities were the same. This capacity for retaining velocity also means a flatter trajectory, and consequently it will be realised that a good Ballistic Coefficient is a most important factor in any projectile.

The Ballistic Coefficient is invariably denoted by the letter "C" and depends on the weight of the projectile, its diameter, the shape of its head, and the tenuity or density of the atmosphere. In sporting gunnery this last factor is always assumed to be unity because it really does not have any practical effect in sporting ranges. The first three factors are, however, most important: the greater the weight, the smaller the diameter and the sharper the head, or nose, of the bullet, the better is its Ballistic Coefficient. In sporting gunnery the Ballistic Coefficient, or C, is always taken as being equal to $\frac{w}{nd^2}$, where w is the weight of the bullet in pounds, d the diameter of the bullet in inches, and n is an empirical value indicating the shape of the head.

The most difficult problem which the amateur ballistician has to face is the correct determination of n. Values of n for all British rifle bullets and a good many foreign ones will be found in the Appendix to *Notes on Sporting Rifles*.

Coefficient of Steadiness and Ballistic Coefficient

Question 153.—*In the answer to Question 152 it was stated that a projectile's Ballistic Coefficient was dependent upon its weight, diameter, shape and the density of the* *atmosphere. It is not also partially dependent upon the steadiness of the projectile during flight, and is not this degree of steadiness indicated by the Coefficient of Steadiness ?*

Answer.—In artillery work the Coefficient of Steadiness is taken into account and this is denoted by the Greek letter σ. In actual fact, however, little is known of the exact relation between a projectile's steadiness (or unsteadiness) during flight and its capacity for overcoming air resistance. In problems connected with sporting gunnery the Coefficient of Steadiness is either ignored entirely or invariably assumed to be equal to unity. The result is the same.

INDEX

Accuracy of different Barrel Lengths, 127
— — Double-Barrelled Rifles, 122
Action Springs, Compression of, 101
Actions, Bolt and Hammer, Quickness of, 120
— Box Lock and Side Lock compared, 26
— Loose, Detection of, 102
Air-Cushion Wads, 71
Air Resistance and Muzzle Velocity, 91
Allowance, Forward, 55, 56, 57, 58
Alteration in Fit of Gun, 30
— — Rifle's Elevation, 116
Altitudes, High, Effect on Sighting of, 123
American Rifles, Designation of, 130

Ballistic Coefficient, 141, 143
Ballistics of different Barrel Lengths, 127
Barrel Length and Velocity, 127
Barrels, Shotgun, Best Length of, 24
— — Going off together, 34
— — Possibility of Shortening, 25
Blueing of Barrels and Actions, 105
Bores, Comparison of different, 35
— Relative Powers of, 36, 37
Bruised Cheek, 46
Bruised, Finger, 45
Bulk Powders, 62
Bullet Stability and Rifling, 138

Caps and Powders, 68
— Large Continental, 69
— Non-Rusting, 109
Cartridges, All-Metal, 52
— Jammed, 33
— Long in Short Chambers, 54
— Non-Rusting, 109
— Perfect, or Thin Brass, 51
— Short in Long Chambers, 53
— Shotgun and Weather, 74
— — in Extreme Cold, 76
— — Storage of, 75
— — Wet, 73
Cartwheel Patterns, 19
Chamberless Guns, 32
Choke, Effect on Velocity of, 21
— Pattern given by Full, 20
— Position in Barrel of, 21
— Possibility of Widening, 22
Clean Rifle, First Shot from, 128
Cleaning after firing "Non-fouling" Bullets, 112
— — Wet Day, 99
— Firearms with Water, 111, 113
— with Wire Brushes, 107
Coefficient, Ballistic, 141, 143
— of Steadiness, 143
Colour of Lock Plates, 105
Compensation in Rifles, 117
Compression of Action Springs, 101
Constant Volume Loading, 71
Contractile Bullets, 136

Cordite and N.C. Powders, 134
Cork Wads, 70
Crimp Turnover, 50
Cylinder, Improved, 18

Dents in Shotgun Barrels, 103, 104
Diameter and Length of Shot Column, 59
Double Rifles, Accuracy of, 122
— — Regulating of, 121
Drift, 134

Extreme Killing Range of 12-bore, 93
— Range of 12-bore, 93

Fibrous Powders, 63
Fit of Gun, *Alteration in*, 30
— — — Effected by Barrel Length, 30
— — — Over and Under, 31
Flip, 114, 115, 116, 117
Forward Allowance, 55, 56, 57, 58

Gelatinised Powders, 63
Gun Headache, 47
Guns, Chamberless, 32

“Hard Shooting” of Guns, 38
Headache, Gun, 47
Horizontal and Vertical Shots, 50

Improved Cylinders, 18

Jump, 114

“Lead” in Rifle Barrels, 125
Leading in Shotgun Barrels, 108
Length and *Diameter* of Shot Charge, 59
— of Barrels, Best, 24
Lethal Bullets, 136
Light-Weight 12-bores, 22
Low Velocity Load, 48

Mauser Action, 129
Mean Point of Impact, 118
Metallic Fouling, 111
Miss-fires, 97

Nitro-Cellulose Powders and Cordite, 134
— Powders, 135
Nitro Proof for Shotguns, 79
Non-Rusting Caps and Cartridges, 109
“Not for Ball,” 77

Obstruction in Bore, Effect of, 40
— of Muzzle, 42
Oil as Obstruction, 42
— in Barrel, Effect of, 39

Patterns at different Ranges, 18
— Cartwheel, 19
— Full Choke, 20
— Possibility of widening, 21
Penetration of Large and Small Shot, 81
— Test for, 89
Pitting in Shotgun Barrels, 98
Powders and Caps, 68
Powders, Bulk, 62
— Classification of, 62
— Effect of different, 61
— — on Recoil, 60
— Fibrous, 63
— Gelatinised, 63
— Progressive, 64, 65
— “Quickness” of, 67
— Shotgun, for Hot Climates, 77
Pressure and Velocity, 90
Problem, An old, 139, 140
Projectiles for Shotguns, 136, 137

Proof, Nitro, 79
— Safety provided by, 79
Pull-Throughs for Shotguns, 107

Recoil from different Powders, 66
— of Short-Barrelled Guns, 23
Ricochets off Water, 129
Rifles, Alteration in Elevation in, 116
— Cleaning after firing, 109, 110, 111, 112, 113
— — with Water, 113
— Compensation in, 117
— Double, 121, 133
— First Shot from Clean, 128
— Take-Down Models, 131

Safety Catches, 35
Shot Charge, Diameter and Length of, 59
— Chilled and Drop, 86
— Column, Length of, 83
— Effect of Swing on, 84
— — — Wind on, 81
— Mould, 88
— Penetration of, 81
— Plated, 88
— Sizes, Best, 85
Shot Sizes, Lettered, 88
— Spread of, 83
Shotgun Projectiles, 137
Shotguns, Sizes of, 17
Silencers, 132
Stock, Measurements of, 29
Stocks, Weights of, 28
Stream-Line Bullets, 125, 126
Striker-Blow, Strength of, 39

Take-down Model Rifles, 131
Trigger-Pulls, Weights of, 26
Turnover, Fully Crimped, 50

Velocity and Pressure, 90
— Effect of Reduced Charge on, 92
— — — Shooter's Weight on, 92
— Muzzle, Effect of Air Resistance on, 91
— Remaining, of Projectile fired vertically, 94
— Terminal, 94, 96
Vertical and Horizontal shots, 59

Wads, Air-Cushion, 71
— Cork, 70
— Importance of, 69